NASA CR-181403

(NASA-CR-181403) USING BIBLIOGRAPHIC DATABASES IN TECHNOLOGY TRANSFER (University of Southern Mississippi) 235 p
Avail: NTIS HC A11/MF A01 CSCL 09B

N88-11399

Unclas
G3/62 0104956

# Using Bibliographic Databases in Technology Transfer

G. David Huffman, Ph.D.
University of Southern Mississippi
Southern Station, Box 5165
Hattiesburg, MS 39406

Contract No. NS-2402
OCTOBER 1987

NASA

# HOW TO USE BIBLIOGRAPHIC DATABASES IN TECHNOLOGY TRANSFER

Technology transfer locates existing technology that addresses a specific need and that is in a form usable and understandable to the recipient. This normally implies the secondary utilization or application of technology for purposes other than those for which the technology was originally intended or created. Under most circumstances, the technology must also be reformatted so that it can be used by the recipient.

Technology transfer is a diverse field. This book deals specifically with demand-pull technology transfer -- technology transfer that arises from need recognition. Using Bibliographic Databases in Technology Transfer is a guide for conducting demand-pull technology transfer studies. The book can be used by a researcher as a self-teaching manual or by an instructor as a classroom text.

Using Bibliographic Databases in Technology Transfer presumes that the reader has a rudimentary knowledge of microcomputer operation -- ability to install software programs, format disks, familiarity with peripherals, etc.,-- access to NASA RECON, and access to an IBM-compatible microcomputer having 524 kb of main memory, a removable 360 kb disk drive, a 10 mb fixed disk drive, a programmable modem (Hayes compatible) and a printer. While some of the book examples can be replicated with a simple printing terminal, most cannot.

The book contains a complete practice set (Appendix 3) which employs the above computer equipment and two software programs -- Smartcom II and SORT-AID. An alternate communications program can be substituted for Smartcom II without significant loss of content. There is -- at present -- no alternate for SORT-AID. Summarizing, the reader or instructor should collect the hardware and software prior to using the book.

The demand-pull technology transfer process is extremely complex: it requires an understanding of computerized, bibliographic databases, indexing practices, computer operation, and reformatting technology. Chapter 1 describes these processes and gives the reader an introduction to the steps and complexity involved. Chapter 1 also provides some examples of technology transfer. A list of technology transfer service organizations is given in Chapter 1 for the reader who feels that technology transfer can be useful, but does not want to become an expert in the demand-pull technology transfer process.

Chapter 2 consists of a cursory overview of technology transfer, definitions of various modes of technology transfer, an overview of <u>Using Bibliographic Databases in Technology Transfer</u>, the steps in demand-pull technology transfer, and a chart showing the book sections which correspond to the various steps in the demand-pull process. Chapters 3 through 8 explain the steps in detail.

In either the self-teaching or instructor mode, the book user should first read Chapters 1, 2, 3, 4, and 6. These chapters provide a basic foundation for online searching using NASA RECON and a microcomputer communications program. To provide hands-on-experience, the reader should replicate the practice set through Screen 17 (Appendix 3). Using the Chapter 4 examples as a guide, the various NASA RECON commands can be replicated and expanded.

The user should now read Chapters 5, 7, and 8, and complete the practice set of Appendix 3 -- screens 18 through 28. At this point, the reader or instructor can amplify the book material in the following ways:

i. Using NASA RECON and the material in Chapters 4 through 7, formulate alternate example problems and search strategies.

ii. Using Chapters 3, 5, and 7, conduct the same technology transfer study using multiple databases. This will require access to the appropriate databases and the related user's manuals.

iii. Using either i or ii above, obtain full-text documents and apply the concepts of Chapter 8 to reconfigure the technology. This requires considerable lead-time; the instructor should obtain this material in advance of the course.

The above examples reinforce searching, search strategy, technology analysis, and technology tailoring to the end-user.

The instructor or reader can also emphasize software systems. Chapter 6 lists many alternate software packages. These can be obtained, integrated, and a searcher's workstation assembled.

The material in the book will provide adequate breadth and depth for self-instruction. It is also suitable for short-courses, i.e., intensive two-to-three day professional training seminars. In fact, the material may have to be abridged for a two-day session. The material may not be sufficient for a full semester course; the instructor should amplify the book as recommended above.

_Using Bibliographic Databases in Technology Transfer_ is itself the result of a technology transfer study. All of the material in the book -- aside from the examples -- has been drawn from existing sources and reconfigured to a text book orientation. The book was extensively edited by Dr. Bonnie Carter -- author of two textbooks on technical writing -- and edited and typed by Mrs. Judy Huffman. The book was written under NASA National Space Technology Laboratory sponsorship and Mr. Robert Barlow provided invaluable assistance. Last but not least, I alone am responsible for any errors in the book.

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CHAPTER 1

# TECHNOLOGY TRANSFER - WHAT IS IT AND WHAT CAN IT DO FOR YOU?

## 1.1 What is Technology?

Webster defines technology as

> "an applied science; a technical method of retrieving a practical purpose; the totality of the means employed to provide objects necessary for human substance and comfort"

In more general terms, technology encompasses devices and systems and the means used to design, engineer, manufacture, and improve such devices.

Technology can be used in a broad context, such as automotive technology, or in a very narrow context, such as high Mach number, airfoil design technology. The former encompasses all aspects of automotive design, development and manufacturing while the latter deals with methods to design airfoils for high velocity operation. In one context, technology covers the complete spectrum from basic research to manufacturing -- conceiving the basic concept, developing an understanding of the concept through basic research, converting the concept into a physical device by means of engineering, improving the device via development, and providing the device to the consumer through manufacturing.

## 1.2 What is Technology Transfer?

While technology encompasses all steps in using technical methods to achieve a practical purpose, technology is often viewed only as the product of research and development activities. These processes are carried out by universities, government laboratories, companies, businesses and industry. The definition of technology alludes to a goal orientation, that is, research and development are undertaken in order to solve a specific problem or reach a specific goal. In some cases, however, research may be undertaken with the objective of developing an understanding of a phenomena. As a consequence, basic research may or may not produce technology.

Even though technology development is directed toward a specific goal, the results of the process may have other applications. When technology developed for a specified purpose is used in another application, the process is called technology transfer. In essence, technology transfer is the application of an existing technology to a new use or user and may be a direct application or may include the tailoring of an existing technology to its new environment.

## 1.3 Some Examples of Technology Transfer

Examples of technology transfer abound. In fact they fill many books, see Appendix 1. Bibliography. Three recent examples, NASA Tech Briefs [1986], illustrate the breadth of the field. Disneyland's Submarine Voyage utilizes painted models of the sea floor. The chlorine in the water degraded the paint and the figures had to be removed, cleaned, painted and reinstalled every three months. A NASA-developed photopolymer, originally designed to protect lens in space, is now being utilized and has reduced the maintenance by a factor of three.

Fabric manufacturers were experiencing excessive metal fatigue failures in fabric looms. A technology survey unearthed a shot peening method used by other firms to improve metal life. This technique introduces a residual compressive stress in the metal and has significantly improved loom life.

An air conditioner manufacturer desired to increase the moisture removal, i.e., dehumidification, capacity of its systems. A study of existing technologies found that the system capacity could be doubled by using a heat pipe dehumidification system. The transferred technology was implemented without significant cost or size increases.

These examples illustrate both the scope and breadth of technology transfer. In some sense, the examples are deceptively simple. The new technology does not magically appear -- it must be located, tailored to the new application, reduced to practice and finally, implemented in the production process. These issues are discussed in the following sections.

## 1.4 Locating Technology

Suppose you operate a small business and are confronted with a problem in your production process or your product. Having tried all the solutions that seemed logical and some that didn't, you are at wit's end. Should you hire a consultant, start a research and development program or try technology transfer?

While any one or a combination of all three may be effective, technology transfer is a logical first choice. Why? If the technology exists, using someone else's research and development will be far less costly than either a consultant or your own research and development. In the end, you must implement the solution yourself and so an understanding of the process is imperative. Implementing someone else's solution requires the same understanding as implementing your own. So you decide to give technology transfer a try.

How do you locate technology? While the definition of technology encompasses both physical devices and design methodology, technology transfer deals principally with documented (written) technology. This takes the form of technical papers and presentations, reports, product specifications, patents, data, etc. Obviously, trying to rummage through a million publications to find a solution to your problem is not very palatable. There is, however, an alternate -- computerized, bibliographic, databases.

Today almost all technical publications, reports, patents, specifications, etc. are located on one or more bibliographic databases. Almost all databases contain an abstract of the publication with a few containing the full text of the document. These databases contain at least a brief summary of virtually all documented technology developed in the United States in the last fifteen years and are the starting-point for any technology search.

To use these databases, you must first define your problem. Start with a brief (one-to-two paragraphs) summary and broad definition of the problem, e.g., "a cooling fan blade strikes a heat exchanger damaging both". Then proceed to be more specific, e.g., "a metal fastner attaching the fan to the air-conditioning case assembly fails after 200-300 hours of operation allowing the fan blade to strike the heat exchanger fins". It is also useful to try to categorize the problem in technical terms, e.g., "the failure of the threaded carbon steel fastner is probably due to vibration, induced fatigue although the failure mechanism cannot be replicated in laboratory tests".

The broad and specific descriptions of your problem will be used to formulate keywords. Two descriptions will provide a spectrum of these keywords ranging from very general to very specific. In addition to the keywords drawn from the problem description, lists of words and phrases normally used to describe the topic will be useful. Again, these should be organized by specificity, i.e., more general to more specific. If logical relationships between the terms exist, they should also be stated.

Locating technology is a somewhat hit and miss proposition. While you probably lack any specific publications dealing directly with your problem, related references can be useful in locating technology. These can provide authors' names and organizations which can be useful in the process.

The process of locating technology can vary from a search conducted on a very wide basis to one that is very specific. In our fastner example, you could collect all technology associated with the fatigue of materials or just the technology related to vibration, induced threaded steel fastner fatigue. Even the latter might be thousands of documents. As a consequence, it is useful to define the comprehensiveness of the search and the number of documents you expect.

Many computerized, bibliographic databases contain titles and abstracts for publications dating to the early 1960's. While most of these publications are in English, many articles may have English titles and abstracts but the actual text is written in German, French, Russian, Japanese or other foreign languages. If you are interested in only recent publications, i.e., 1980 or later, written in English, these limitations should be stated in the problem statement.

The problem statement is the starting point of your search for technology. In some ways, this search is like finding an address in a large metropolitan area using a map. You must know where you are on the map to start the process. The problem statement is analogous to locating your current position on the map. Since the problem statement is your starting point, the various elements to be included are listed in Table 1.1.

TABLE 1.1

ELEMENTS TO INCLUDE IN A
TECHNOLOGY TRANSFER
PROBLEM STATEMENT

**Brief summary of the problem**

General description
Specific description
Technical or phenomenological description

**List of words and phrases normally used to describe the topic**

General terms and phrases
Technical terms and phrases

**Order words and phrases**

List all terms from the most general to the most specific
List any logical relationships between the terms

**Lists of related references**

Journal articles
Government reports
Industrial reports
Presentations
Patents

**Breadth of the search**

Search comprehensiveness
Number of citations expected
Limitations by date or language
Expected cost

Having defined your problem, you must now select an appropriate database. There are more than four thousand available, so it is highly likely that at least one is relevant to your problem. Once the database is selected, the problem statement is used to formulate "keywords". The database articles are indexed by keywords and when your keywords match those of an article, the document is "retrieved". In the previous example, the keywords might be "fastners", "fans", "fatigue", "vibration", etc. Perhaps the retrieved documents will solve your problem. If not, they will provide other areas to investigate, a source of experts in the area, etc.

If this process sounds complicated, it is! Having read this fairly short description of technology transfer, you may decide to hire a consultant. But don't give up on technology transfer yet. The following section provides some organizations which furnish technology transfer services.

## 1.5 Obtaining Technology Transfer Services

Locating technology is far from a simple task: it requires an understanding of computerized, bibliographic databases, indexing practices and computer operation. Furthermore, it is fairly high risk. Failure to locate the relevant technology may be due to an inability to use the database systems, the absence of the technology, or both.

All businessmen are familiar with "make or buy" decisions. Should you carry out your own technology transfer studies or should you purchase the service? The decision is largely based on economics. If you envision numerous technology transfer studies, doing them yourself may be cost effective recognizing the inevitable learning curve. On the other hand, if studies are infrequent or your labor costs are high, purchasing the service may be the logical choice. It is important to note that technology transfer professionals are likely to be more cost-effective in the short term than your own staff.

If you elect to purchase the service, two questions come to mind. What does it cost and where do I purchase it? Addressing the second question, there are many independent companies and a number of governmental agencies which provide technology transfer services. Lucas and Marcaccion [1987] and Technology Transfer - Survey of an Emerging Service Industry [1970] list private firms which provide services.

Of the federal agencies, NASA is by far the most active in technology transfer. NASA's founding charter mandated technology transfer and the agency has pursued an agressive program of commercialization of aerospace technology. NASA has established a series of Industrial Application Centers (IAC) with the mission of transferring technology to industry. Each of the IACs functions as an independent organization and provides services to clients on a fee basis. The IACs, the host institution, geographic location, and telephone numbers are given in Table 1.2.

The number and diversity of organizations providing technology transfer services makes the cost of services quite varied. Costs for our example of Section 1.4 would range from a few hundred to perhaps $5000. The service provided at the lower level would consist of a single database search and a computer listing of the retrieved abstracts. At the upper figure, the technology transfer concern would attempt to solve the problem, i.e., conduct multiple database searches, retrieve abstracts, collect and analyze full-text articles, provide engineering services to tailor the technology to the specific problem and document the results in a technical report.

## 1.6 Summary

This chapter defines technology and technology transfer and provides a few, selected examples of the process. A general framework for locating technology is described. Finally, some technology transfer organizations are discussed. The remainder of this report describes the technology transfer process in some detail. If you have elected to try the process yourself, read on. If not, contact one of the NASA organizations of Table 1.2 or locate a private technology transfer firm. Good luck!

TABLE 1.2

NASA'S INDUSTRIAL APPLICATION CENTERS

| Industrial Application Center | Host Institution | Location | Telephone Number |
|---|---|---|---|
| Aerospace Research Applications Center | Indianapolis Center for Advanced Research | Indianapolis IN | (317) 262-5003 |
| COSMIC | University of Georgia | Athens GA | (404) 542-3265 |
| NASA Industrial Applications Center | University of Pittsburg | Pittsburg PA | (412) 648-7000 |
| Southern Technology Applications Center | University of Florida | Gainesville FL | (904) 392-6760 |
| Kerr Industrial Applications Center | Southeastern Oklahoma State University | Durant OK | (405) 924-6822 |
| NASA/UK Technology Applications Center | University of Kentucky | Lexington KY | (606) 257-6322 |
| WESRAC | University of Southern California | Los Angeles CA | (800) 642-2872 -CA only<br>(800) 872-7477 -toll-free US |
| Technology Applications Center | University of New Mexico | Albuquerque NM | (505) 277-3622 |
| NERAC | NERAC, Inc. | Storrs CT | (203) 429-3000 |

## 1.7 References

Lucas, A. and Marcaccio, K.Y., editors [1987] 1987 Encyclopedia of Information Systems and Services: Volumes 1, 2 and 3, Gale Research Company, Detroit, Michigan.

NASA Tech Briefs [1986], Volume 10, Number 6, Associated Business Publications, New York.

"Technology Transfer - Survey of an Emerging Service Industry" [1970], TTA Information Services Company, San Mateo, CA.

# CHAPTER 2

# AN OVERVIEW OF TECHNOLOGY TRANSFER

## 2.1 Innovation, Technology Diffusion and Technology Transfer

Technology transfer is a field replete with a variety of subfields, areas of application and definitions. While no individual work is likely to codify technology transfer, this book defines the various elements, surveys the kinds and types of transfers, and provides in-depth coverage of one method and/or approach to technology transfer.

Depending upon the point of view, technology transfer is made up of and/or is a sub-element of innovation and technology diffusion. Innovation has been considered as both an item and as a process. Barnett [1953] defined innovation as

> "... any thought, behavior or thing, that is new because it is qualitatively different from the existing forms".

and Rogers [1962] as

> "An innovation is an idea perceived as new by the individual. It really matters little, as far as human behavior is concerned, whether or not an idea is objectively new as measured by the amount of time elapsed since its first discovery".

Both the above definitions emphasize newness but overlook the element of implementation. Thompson [1969] incorporates this important factor and defines innovation as

> "By innovation is meant the generation, acceptance and implementation of new ideas, processes, products or services. Innovation, therefore, implies the capacity to change or adapt".

Thus, the innovative process actually combines the elements of creating an idea with implementing the concept. This is clarified by Schon [1967] who states

> "Invention is the process of bringing new technology into being or new technology created in processes; but innovation means the process of bringing invention to use".

As will be seen this definition encompasses both technology diffusion and technology transfer.

Diffusion can be defined as an intermingling resulting from random agitation. Technology diffusion is the more-or-less uniform dispersion of an invention without external intervention. For example, microcomputer technology is now used in microcomputers, in instrumentation systems, in control systems, in automation systems, etc. Microcomputers were originally largely limited to desk top computers but now can be found in automobiles, cash registers, typewriters, video cassette recorders, home audio systems and many other applications too numerous to mention. This is a good example of technology diffusion.

Technology transfer differs from technology diffusion in that the dispersion process is directed. Gee [1974] states

"Perhaps a helpful approach is to distinguish technology from science. Whereas science is concerned with the increase of knowledge and understanding, technology is directed toward use. Whereas the result of scientific research is usually publication of a paper, the output of technological activities is a product, process, technique or material developed for some specific use. .... Patents are more commonly the outgrowth of technology rather than of science.

The activity involves principally the increased utilization of a proven technology base rather than its expansion through further research and development.

For our purposes we may consider technology transfer to be the application of technology to a new use or user. It may be a direct application or may include the need for adapting or tailoring the technology to its new use or user".

In summary, technology transfer can be defined as a directed process by which technology developed by one organization for a specific purpose becomes adopted and applied by another group or organization for frequently different purposes. As can be seen, technology transfer is related but distinct from both innovation and technology diffusion.

## 2.2 Categorization of Technology Transfer by Source and Recipient

As you can surmise from the foregoing discussion, technology transfer is an all encompassing topic. There are many ways to categorize technology transfer. The simplest categorization scheme uses the source and utilizer of the technology with the two linked by the technology transfer mechanism. This model is depicted in Figure 2.1. The figure shows the source and utilizer as independent entities. This is not necessarily the case and the technology transfer process can be inter- or intra-organizational.

The source-utilizer model can be made more specific by considering the source-utilizer characteristics. Typical partners are:

i. Country-to-country
ii. Industry-to-industry
iii. Federal government-to-industry
iv. Federal government-to-state and local government
v. University-to-industry

Examples of these processes are well documented and are described in the journal articles and reports which are listed in Appendix 1. Bibliography.

Technology transfer can also be categorized as vertical or horizontal. Vertical transfer refers to additional uses of the same technology while horizontal transfer refers to the adaptation of a technology from one application to another. Vertical transfer is most likely to occur within an organization while horizontal transfer would most frequently occur between two organizations.

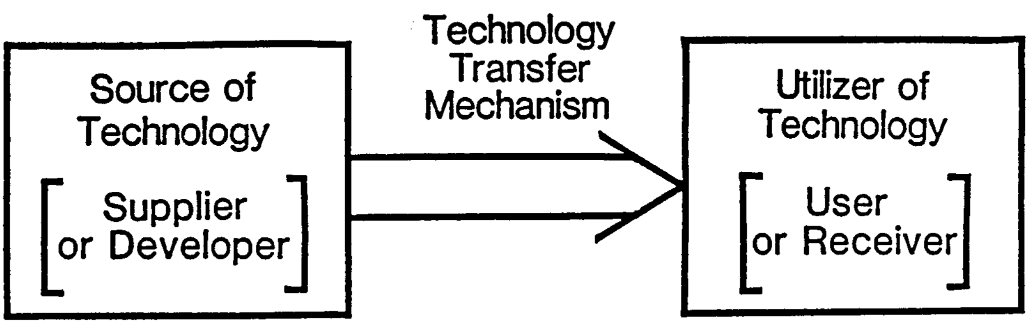


Figure 2.1. An Elementary Model of Technology Transfer

## 2.3 Technology Transfer Models

Technology transfer can be categorized and/or analyzed from a number of different viewpoints. Quantification of the myriad approaches is limited because the process is complex and proceeds over a long time span. Eight to fifteen years may elapse between the time technical information is generated and the time it is used in an innovation. As a result, analysis of technology transfer has been largely limited to isolated case studies. Despite these shortcomings, models are useful in that they provide a logical framework for review of the various factors influencing the process.

The technology transfer process can be modelled from a number of perspectives. Since the process is strongly dependent on individuals, it can be analyzed from the viewpoint of personality traits. Technology development is largely carried out by large organizations and, thus, the process can be viewed from a corporate perspective. Technology transfer can also be viewed from an information flow point of view. The corporate and information flow models -- the most relevant for the current book -- will be discussed in more depth in the following paragraphs.

The model of Jolly and Creighton [1977] as later modified by Roland [1982] is shown in Figure 2.2. These authors divide the parameters influencing the process into two broad categories: formal and informal factors. The formal factors are the form and/or documentation of the technology along with characteristics of the receiving organization. The informal factors are the characteristics of the personnel in the receiving organization. The process is depicted as uni-directional. In many cases, however, the transfer may involve considerable feedback between the technology source and user.

Huffman [1985] and Gee [1974] view technology transfer from an information flow or problem solving perspective. The information flow model is more specific than the previous one and is based on recognition of a specific technology need. Gee [1974] states

> "In fact, recent results from different researchers indicate that most successful innovations arise from need recognition rather than idea generation or inventions.... . That is, demand-pull rather than technology-push was found to be the stimulus in most cases of successful innovations".

Demand-pull technology transfer can be defined as locating and tailoring technology to solve a specific problem. A flow chart showing the steps in the demand-pull technology transfer process is given in Figure 2.3. This chart or model will be used throughout the book.

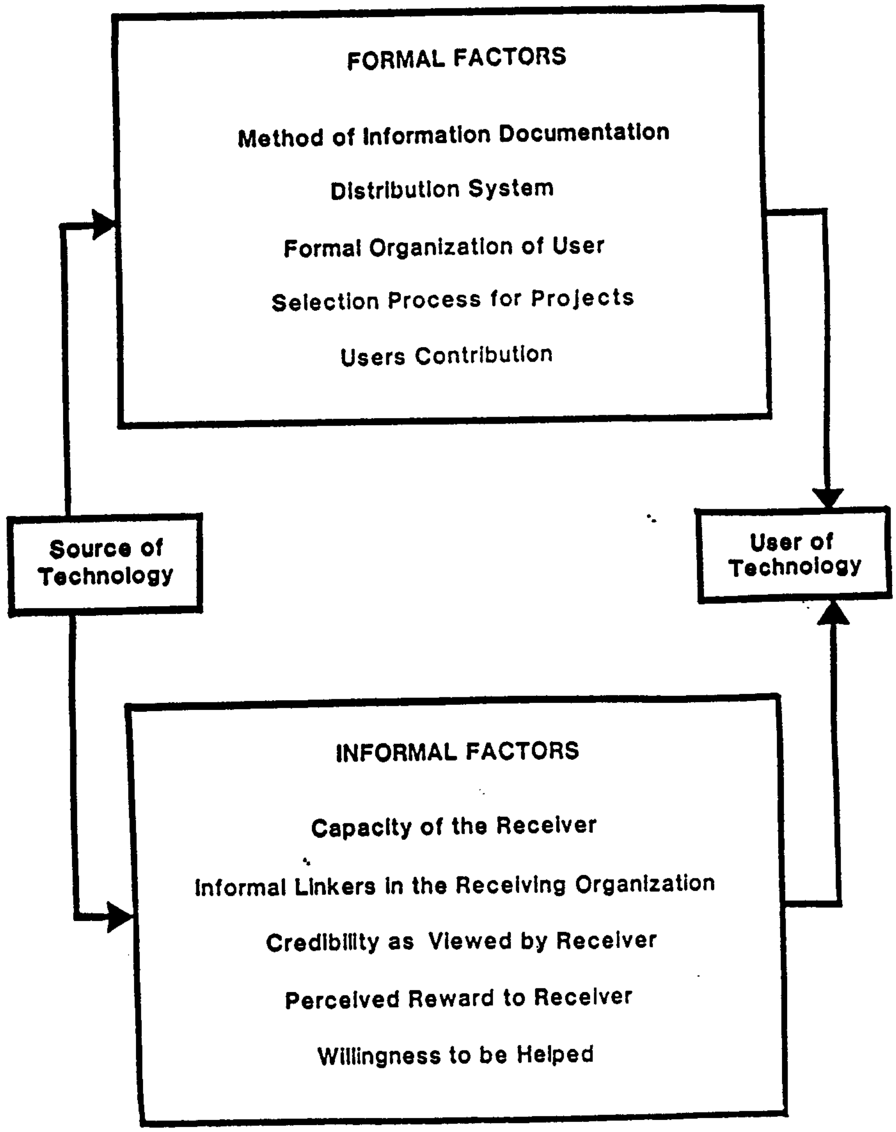


Figure 2.2 Information Linker Model of Technology Transfer

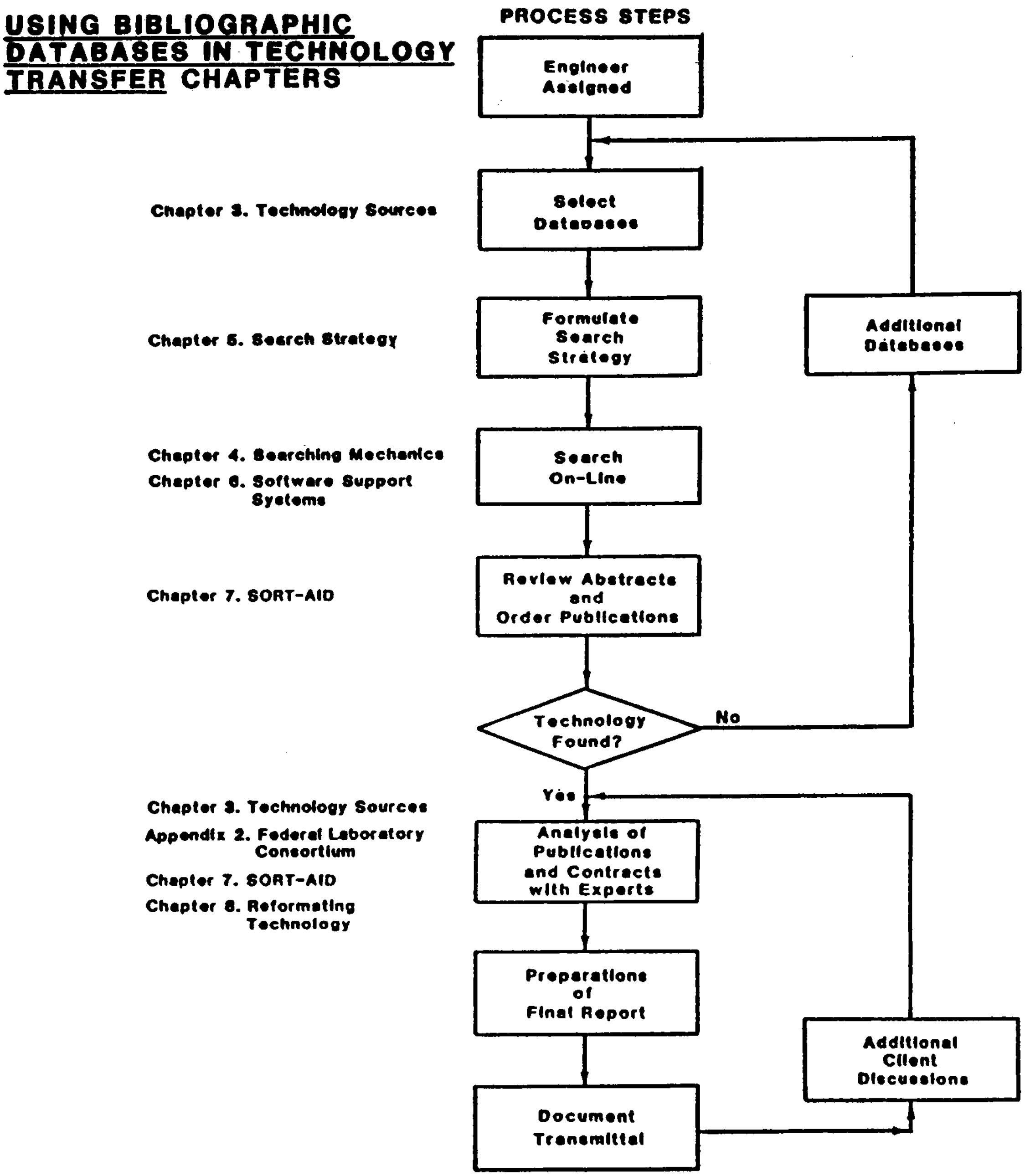


Figure 2.3 Steps in a Demand-Pull Technology Transfer Process

## 2.4 Goals and Objectives of Using Bibliographic Databases in Technology Transfer

As can be seen from Sections 2.1, 2.2 and 2.3, technology transfer has many facets. Studies in the area deal with specific instances of technology transfer, models of the process, governmental policies, institutional procedures and organizational structures, etc. (see Appendix 1 for additional reading on these topics). One might conclude that everything that can be written about the topic has been written. Why then another book on technology transfer?

While much has been written, little of the information deals with the specific practices employed in demand-pull technology transfer. Furthermore, much of the available information is dated and does not describe the use of new computer-based techniques. The objective of Using Bibliographic Databases in Technology Transfer is, thus, to alleviate the shortcomings of the current literature. In particular, this book will describe specific technology transfer practices in sufficient detail to allow their implementation in government laboratories, industries, commercial concerns and universities. In essence, Using Bibliographic Databases in Technology Transfer is a guide for conducting demand-pull technology transfer studies. The book can be used by a researcher as a self-teaching manual or by an instructor as a classroom text.

## 2.5 Overview of Using Bibliographic Databases in Technology Transfer

Using Bibliographic Databases in Technology Transfer is a textbook on demand-pull technology transfer. The document provides an overview of the innovative processes, a review of technology sources, the use of bibliographic databases, and methods of analyzing and reformatting technology for the end-user. The book is organized along the lines of the flowchart of Figure 2.3. The book chapters corresponding to the steps in the demand-pull process are shown in Figure 2.3. The book deals with a specific technology transfer process; it is complete and should provide a useful training and educational medium.

## 2.6 References


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# CHAPTER 3

# TECHNOLOGY SOURCES

## 3.1 Introduction

The industrial application study of Section 2.3 relies principally on two technology sources -- **bibliographic databases and technology experts.** The use of computer-based bibliographic databases is an involved process; it is be described in overview in following sections and in-depth in Chapter 4. Input from technology experts, an important element in the technology transfer process, is also discussed.

## 3.2 Online Services

### 3.2.1 Historical Perspective

In recent years, technical information has been expanding at an exponential rate. As a result, it is difficult to remain abreast of all developments, even for specialists in a very narrow area. The number of technical journals has grown rapidly as has the number of secondary abstracting services, i.e., indexes of source journals by author and/or topic. The development of these abstracting services coupled with electronic publishing has yielded a new technology -- computer searching. This approach provides a systematic and effective method of literature searching.

Computer systems are well suited to the repetitive tasks associated with text processing. Particularly effective when the data is in electronic form are sorting and reformatting of abstract collections. Printing of documents (type sizes and fonts, layout, and text justification) is also effectively conducted on computer systems. The economics of automated publishing produce -- as a by-product -- data on journal references in a computer-readable form. This, in turn, provides the "raw material" for computer-searching.

Computerized searching of machine-readable bibliographic databases was first implemented by the National Library of Medicine (NLM) in the mid-1960's using the Index Medicus and its computerized counterpart, the Medical Literature Analysis and Retrieval System (MEDLARS). NASA also played a key role in the development of machine-readable bibliographic databases and formed the NASA scientific and Technical Information Division in 1962. In fact, the NASA database is the oldest machine-readable file. In the ensuing years, many publishing organizations have used the computer to publish abstracts and/or journals and have generated machine-readable bibliographic databases. Following the lead of NASA and NLM, most scientific and technical journals now have machine-readable abstracts and the related bibliographic databases. As a later development, databases are now appearing in the educational, sociological, economic, business and humanitites areas.

Access to the bibliographic databases was originally carried out in the batch mode, i.e., requests were mailed to the database vendor, requests were collected, the database was interrogated and the results of the search were mailed back to the customer. This was a cost-effective way of searching the computer files, but lacked timeliness. In fact, the searcher could often carry out an abridged manual literature search using printed abstracts in the time it took to conduct the automated computer search. This minimized the impact of the service.

Because of developments in computer and communications technology, bibliographic database services are now offered in an online manner. The online operation allows the searcher to query the database directly, monitor and/or revise the search and transfer the selected abstracts electronically. As a result, the search process can be completed in minutes rather than days. A number of organizations (Lockheed, System Development Corporation, Bibliographic Retrieval Service) now offer these services and the number of online searches is increasing yearly.

### 3.2.2 Information Organization

The need to organize bibliographic information can be illustrated by considering the process of information transmission that occurs when an author writes a paper which is ultimately used by a researcher. The author attempts to describe some elements of reality. The paper consists of a title, abstract, keywords and the text body. The paper is published by a journal which may review and revise the author's manuscript. A computerized, bibliographic database system indexes the paper using the author's keywords and the indexer's or database's subject codes. The researcher locates the paper using keywords, subject codes or other information in the citation. Note that a citation consists of the title, author's organization, the publishing source, the keywords and the article abstract. The researcher's ability to locate the paper will be influenced by both the author's keywords and the database's subject codes. Retrieval of the information can be helped by the use of printed indexes. These indexes are of four types: hierarchial, keyword-in-context, keyword-out-of-context, and coordinate indexes.

Hierarchical indexes present references and/or citations in a logical series of headings and subheadings. Having defined a topical area, the user reviews the listed citations and selects those that are relevant to the specific problem statement. Hierarchical indexes are useful in that they provide access to a large number of citations under controlled categories. Their major shortcoming is the lack of flexibility in the topical categories. The available headings and subheadings may not be consistent with the research area being investigated nor may they reflect recent changes and/or developments in technology.

Keyword-in-context (KWIC) and keyword-out-of-context (KWOC) indexes remove the heading limitations of hierarchical indexes by using keywords and/or title words. Using KWIC and/or KWOC indexes, the user can search for citations which contain specific words or phrases appearing in the title or in indexing lists or terms.

Coordinate indexes form the basis for most computer-searching systems. Each citation is indexed or identified by a unique descriptor, i.e., number or character string. Indexes are generated for a specific term by listing all documents which contain the given term. The document lists constitute the indexes' access points and are printed in alphabetic or numeric sequence. The index is used by first identifying the terms of interest, i.e., search terms or keywords. Under each term, specific document identifiers are listed which can then be linked to the sequential lists of citations.

If a user is interested in the optimal airflow through an automotive radiator, the selected **keywords** might be **airflow, automotive, radiator, heat transfer, heat exchanger,** etc. Under each term one finds a list of **document descriptors.** This is illustrated in Figure 3.1 for the above keywords. The document discriptor appearing under all keywords -- 322-66-7921 in Figure 3.1 -- is then relevant to the problem statement. Using the document descriptor, the citation can then be retrieved and reviewed.

Obviously, printed coordinate indexes can be very useful in library research. As long as the number of terms remains small, the manual processes are tractable. However, when the number of terms and/or the document descriptors per term becomes large, the process becomes very time consuming and unmanageable. Computers, on the other hand, are ideally suited to this task. Computers can compare thousands of document descriptors in a matter of seconds and select the descriptors meeting all of the keyword requirements. This is the basis for the computer search systems.

Keyword

**Airflow**

$$\left.\begin{array}{l}322\text{-}66\text{-}7921\\123\text{-}45\text{-}6789\\594\text{-}62\text{-}7971\end{array}\right\}\ \text{Document Descriptors}$$

.
.
.

**Automotive**

$$\left.\begin{array}{l}123\text{-}45\text{-}6789\\322\text{-}66\text{-}7921\\457\text{-}77\text{-}9280\end{array}\right\}\ \text{Document Descriptors}$$

.
.
.

**Radiator**

$$\left.\begin{array}{l}974\text{-}32\text{-}4671\\101\text{-}11\text{-}6666\\322\text{-}66\text{-}7921\end{array}\right\}\ \text{Document Descriptors}$$

.
.
.

**Heat Transfer**

$$\left.\begin{array}{l}322\text{-}66\text{-}7921\\974\text{-}32\text{-}4671\\459\text{-}60\text{-}9211\end{array}\right\}\ \text{Document Descriptors}$$

.
.
.

Figure 3.1 Keywords and Document Descriptors

### 3.2.3 Computer-based Bibliographic Search Systems

The overall process of online searching is illustrated in Figure 3.2. A microcomputer is connected to the host database system using a telecommunications network. The modem converts the electrical signals from the microcomputer and host database system to audible tones which are then transmitted over the telecommunications network. The host computer is typically a large time-sharing system which can support hundreds of users simultaneously. The bibliographic database files are stored on magnetic disks which allow very rapid access to the databases. The search results can be printed at either the host computer site or at the searcher's workstation.

Searching is performed by looking for a match between user-specified terms and terms stored in the index of journal article citations. The search terms may be words or word phrases. Furthermore, provisions are normally made to match word stems, e.g., COMPUT* will match computer, computing, compute, computable, computation, computer-aided-design, computer engineering, etc. The search may be "free-text" or may be limited to the database dictionary or thesaurus. Many indexers now employ a series of keywords supplied by the article author. These are particularly useful in narrowing the scope of a search. In addition to searching for keywords, searches may also be carried out for an author name, journal title, sponsoring organization, date, etc. In summary, modern systems provide very flexible search systems and all of the previously described search fields can be combined if desired.

The burgeoning number of bibliographic database services has resulted in a large number of searching systems and search protocals. In essence, each of the services uses a somewhat different command language. The command language instructs the host computer system to perform a specified function. The same function is often invoked with different syntax on different systems. This confusion has lead to the development of a new profession -- search expert or search intermediary, e.g., see Section 3.2.4.

Despite command language differences among the various databases and control software, the search organization and operation is virtually the same regardless of databases. Figure 3.3 illustrates a typical search protocol. In the hypothetical protocol of Figure 3.3, the computer system prompts the user for commands with the word USER. The user then enters the various commands. The system responds with all system responses denoted as SYSTEM.

The sequence described in Figure 3.3 addresses the projected sales of solar collectors for 1986 and 1987. The key words of the search are solar collectors, projected sales and 1986-1987. The search is initiated by querying the system for all citations related to solar collectors. This query produces a response of 8,342 citations. These citations relate to all aspects of solar collectors, ie., research, design, operation, costs, performance, etc. The user then collects all citations related to sales -- 22,347 and forecasts or projections --14,637. All three terms are considered jointly in statement 5 and the number of citations drops drastically to 37. Since only current projections are of interest, statement 5 limits the search to 1984 and 1985. Only 8 citations are now appropriate and the various titles are listed in statement 6. The process is described graphically in Figure 3.4 with the over-lap regions shown.

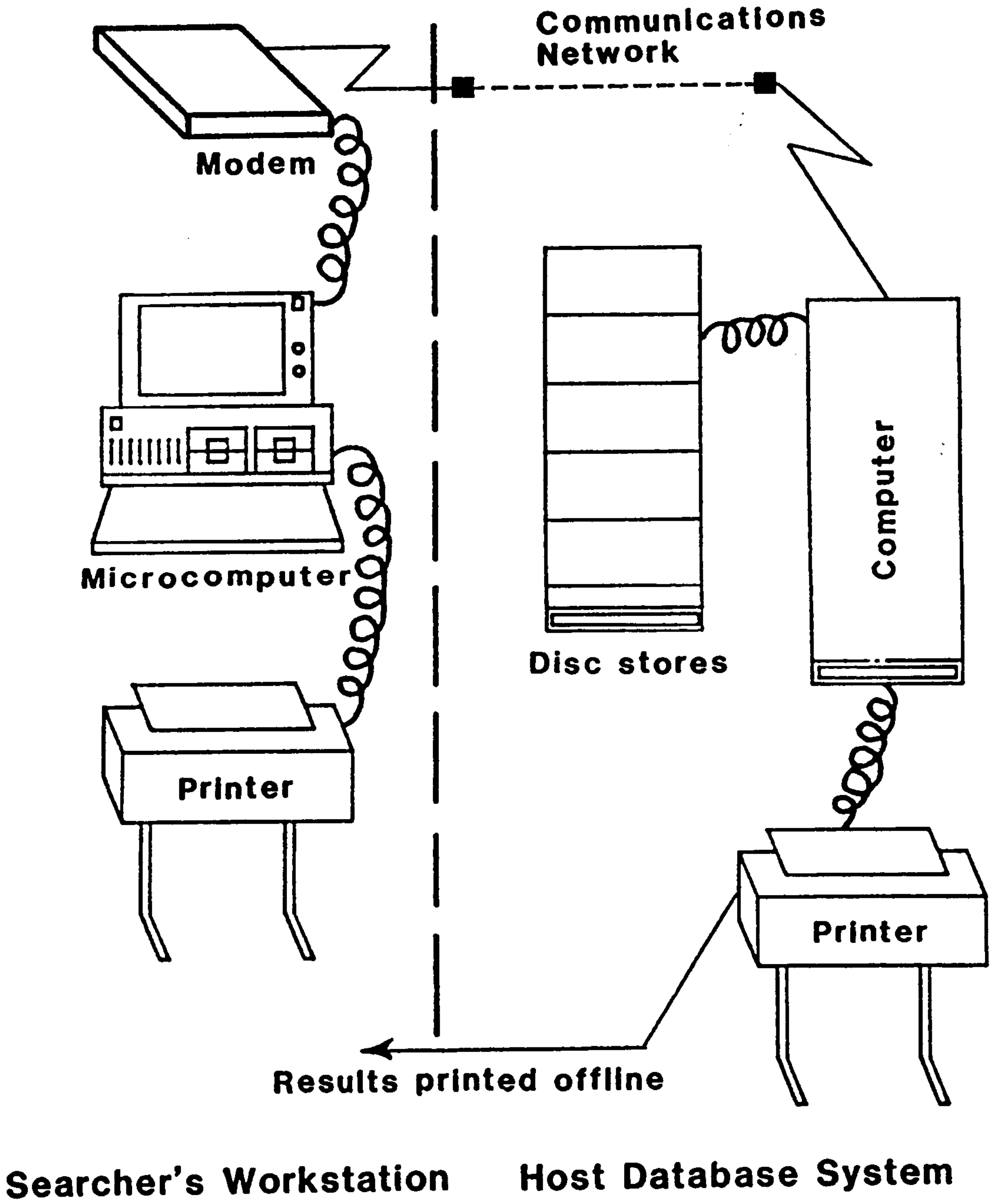


Figure 3.2 The Overall Online Searching Process

Statement 1
USER: Find solar collectors
SYSTEM: 8,342

Statement 2
USER: Find sales
SYSTEM: 22,347

Statement 3
USER: Find forecast* or predict*
SYSTEM: 14,637

Statement 4
USER: Match St1 and St2 and St3
SYSTEM: 37

Statement 5
USER: Limit St4 to Yr=1984 and Yr=1985
SYSTEM: 8

Statement 6
USER: Print Titles for St5
SYSTEM:
1 Title: DOE Projects Solar Collector Sales to Decline
-
-
-
-

Figure 3.3 A Typical Search Sequence

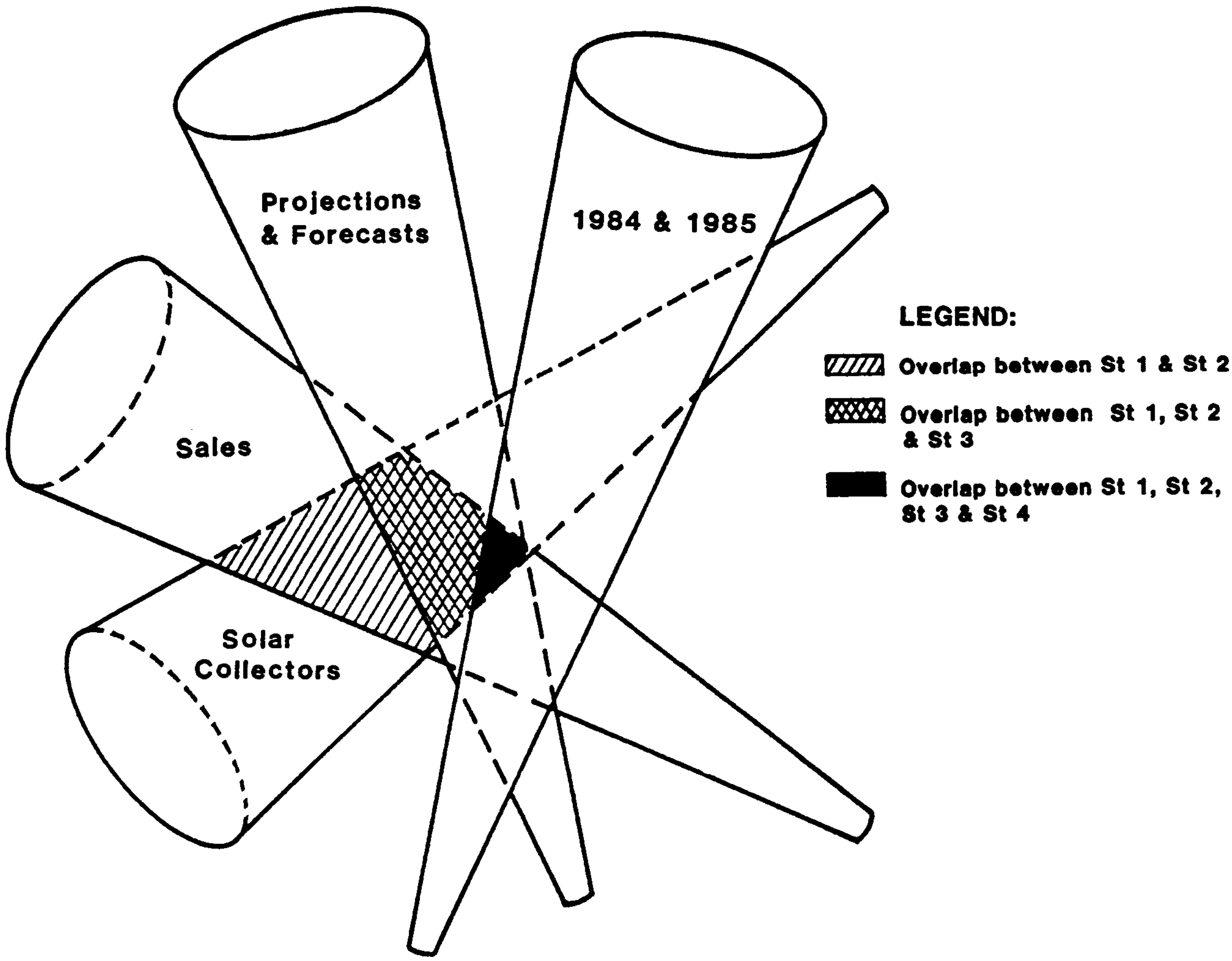


Figure 3.4 Schematic Diagram of the Search Process

### 3.2.4 Client-Searcher Partnership

Computer-based bibliographic retrieval systems were originally conceived as end-user systems: in other words, the engineers, scientists, etc., who sought the information would operate the terminals and/or microcomputers. This has not been the case in most instances. While the reasons for this are numerous, the principal factors are: system and database complexity and search cost. As was noted in Section 3.2.3, the command language or syntax differs among database vendors. An infrequent user is unlikely to be familiar with all the syntax details of a large number of databases. Many databases employ a dictionary or thesaurus. These differ among databases even for the same technical area. Finally, most database vendors charge for service on a "connect-time" and "citation retrieved" basis. As a result, an inefficient search is not only likely to provide poor results, but also likely to cost more in the process. As a result of these factors, a new profession -- search analyst -- has emerged.

The search analyst works in partnership with client, scientist or engineer, i.e., the end-user. The end-user provides a fairly detailed problem statement -- see Section 1.4. The search analyst then selects the appropriate databases. Following the database selection, the search analyst selects keywords or indexing terms from the problem statement, i.e., formulates the search strategy. The search analyst then compares the selected keywords with the database thesaurus and modifies them accordingly. Using the database command language, the search analyst initiates the search and selects titles and/or citations for retrieval online. The end-user reviews the citations online and if appropriate, the search analyst terminates the search. If the citations are not relevant or if too few or too many are indicated, the search analyst reformulates the search strategy and continues the process. In essence, the search analyst and the end-user work together to carry-out the search. The search analyst functions as the information specialist with the end-user functioning as the technical specialist.

As computer retrieval systems become more user-friendly, the direct use of systems by end-users may increase. This will be dictated by a standardization of database command languages and dictionaries as well as access costs. Enhanced user-friendliness is unlikely to overcome command language differences nor increased cost.

## 3.3 Computerized Databases

### 3.3.1 Nomenclature

Because demand-pull technology transfer employs the sciences and engineering, the thesauri and databases discussed in the ensuing sections emphasize these areas. Since scientists and engineers attempt to communicate as precisely as possible, computer searches in these fields are generally more accurate, (the terms used are less ambiguous) than in the social sciences or humanities.

While the technical literature tends to be less ambiguous than that in the humanities, the over-all spectrum of science and engineering is very broad. As a result, the search terms to be employed in technology transfer studies are almost countless. Consequently, a dictionary of terms is essential. Furthermore, ambiguity does exist -- particularly in the naming of chemical substances, minerals, metals, alloys, etc. Standardization efforts are now underway and these are discussed in the following paragraphs.

Substantial standardization has been achieved in the naming of chemical compounds, metals, and alloys through the joint activity of a number of professional societies, i.e., the Society of Automotive Engineers, the American Society for Testing and Materials, the American Chemical Society, etc. In particular, the Unified Number System for Metals and Alloys [1977] is a useful reference for standardized and/or accepted names for metals and alloys.

Valuable guides for use in search formulations related to chemical substances are How to Name an Organic Substance [1977], Nomenclature of Organic Chemistry [1979] and Introduction to Chemical Nomenclature [1979]. Naming guides are also available in the mechanical, civil and electrical engineering area with the Glossary of ASTM Definitions [1973] and the IEEE Standard Dictionary of Electrical and Electronic Terms [1977] being notable examples.

### 3.3.2 Thesauri

Successful searching is largely based on a well constructed strategy along with a comprehensive but relevant group of index terms. Thesauri and/or database dictionaries are invaluable in the selection of search terms. As noted in Section 3.2, many indexing systems employ subject headings or authorized terms. A database thesaurus is a printed list of cross-referenced, authorized terms employed in the computerized database. Generally, the thesaurus displays both the indexing term and a series of related terms.

Figure 3.5 shows an entry from the NASA Thesaurus [1982]. In this case, the search terms -- **Turbulent wakes** -- are preceeded by **swirling wakes** and **wakes** and followed by **slipstreams** and **propeller slipstreams**. The more inclusive or broader terms appear above and to the left of the search term with the narrower and more specific terms appearing below and to the right. RT denotes related terms which are listed below the entry. A hierarchical approach as depicted in Figure 3.5 is used in most thesauri, although the presentation of material may vary from document to document and system to system. It is important to note that the use of a specific subject term, e.g., **turbulent wakes**, in an online search will not -- in general -- retrieve citations indexed under related terms, e.g., **propeller slipstreams**.

A number of scientific and engineering databases have printed and, in some cases, online thesauri. These are of obvious value for the specific databases, but also can provide assistance for searchers working with databases which lack good vocabulary control. Table 3.1 lists some selected thesaurui. In a field developing as rapidly as online searching, no list can claim to be comprehensive. The material is, however, representative and will provide guidance in search structuring.

TURBULENT WAKES

UF Swirling Wakes — Broader Terms

Wakes

. **Turbulent Wakes**

.. Slipstreams — Narrower Terms

... Propeller Slipstreams

RT Aircraft Wakes

Laminar Wakes

Trapped Vortexes

Vortex Advisory System

Vortex Sheets

Vortex Streets

Figure 3.5 An Example of Hierarchical Structure from the NASA Thesaurus [1982]

### 3.3.3 Databases

At the present time 4000-5000 bibliographic and/or numeric databases are available for online searching. These cover the spectrum of topics from agriculture to legal research. Many databases may cover a number of disciplines and will be of interest to the technology transfer professional. Table 3.2 contains selected databases which cover the physical sciences and engineering. While by no means all inclusive, the Table 3.2 entries should introduce the reader to the breadth of coverage available and provide sufficient depth for many technology transfer studies. Additional databases can be obtained from the journals On Line, On Line, Inc., Weston, CT, Database, On-line, Inc., Weston, CT and Directory of Online Databases, Cuadna Assoc. Inc., Santa Monica, CA.

Table 3.1

SELECTED THESAURI FOR SCIENCE AND ENGINEERING

| Title | Description |
|---|---|
| ENERGY DATABASE SUBJECT THESAURUS [1981] | Indexing terms for the Energy Database, i.e. DOE RECON. Contains over 25,000 terms covering all aspects of energy research and development. |
| GEOREF THESAURUS AND GUIDE TO INDEXING, 2nd Edition [1978] | Indexing terms for the BIBLIOGRAPHY AND INDEX OF GEOLOGY. Contains 12,500 entries related to geographic place names, systematic terms for rocks, fossils, minerals, etc. and general subject terms for geologic features, properties, etc. |
| INSPEC THESAURUS [1981] | Indexing terms for the INSPEC database which corresponds to PHYSICS ABSTRACTS, ELECTRICAL AND ELECTRONICS ABSTRACT and COMPUTERS AND CONTROL ABSTRACTS. Contains over 9,000 terms related to physics, electrical and electronics engineering, computer science, computer engineering and related areas. |
| NASA THESAURUS [1982] | Authorized subject terms for the NASA database, i.e., NASA RECON. Contains approximately 21,000 terms related to spacecraft, aircraft and all related areas of science and engineering. |
| THESAURUS OF ENGINEERING AND SCIENTIFIC TERMS [1967] | Primary terminological authority for the National Technical Information Service (NTIS). NTIS is the primary distributor of U. S. government research and development reports and this thesaurus deals with all fields. |
| THESAURUS OF METALLURGICAL TERMS 5th Edition [1981] | Principal vocabulary tool for METALS ABSTRACTS AND ALLOYS INDEX. Contains 9000 terms dealing with all aspects of metallurgy. |
| SHE: SUBJECT HEADINGS FOR ENGINEERING [1980] | Subject authority for ENGINEERING INDEX, i.e., COMPENDEX in machine-readable form. Contains over 12,000 entries dealing with all aspects of engineering. |

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OF POOR QUALITY

Table 3.2 (page 1 of 7)

DATABASES FOR SCIENCE AND ENGINEERING

| Title | Sponsoring Organization | Number of Citations | Dates of Citations | Brief Description |
|---|---|---|---|---|
| APILIT | American Petroleum Institute, Central Abstracting and Indexing Service, New York | 375,000 | 1964 - present | Covers all aspects of petroleum refining research and operations. Publications indexed include trade and professional journals, reports and conference publications. |
| APIPAT | American Petroleum Institute, Central Abstracting and Indexing Service, New York | 95,000 | 1964 - present | Covers patent literature in petroleum refining and parallels APILIT. Includes patents from the United States, Belgium, Canada, France, Germany, Great Britain, Japan, the Netherlands and South Africa. |
| APTIC | U. S. Environmental Protection Agency, Air-Pollution Technical Information Center Research Triangle Park, NC | 89,000 | 1966-1978 | Covers air pollution research and management. Publications indexed include both journal and nonjournal items. |
| BHRA Fluid Engineering | BHRA Fluid Engineering, Cranfield, England | 120,000 | 1974 - present | Covers all aspects of fluid flow, fluid dynamics, fluid technology and materials properties. Publications indexed include journals, books and conference reports. |
| CA SEARCH | Chemical Abstracts Service, Columbus, OH | 5,300,000 | 1967 - present | Computerized version of CHEMICAL ABSTRACTS. Database can be searched by title, by indexing terminology, by CAS registry number and by various alternate indexing methods. |
| CAS Online | Chemical Abstracts Service, Columbus, OH | 6,000,000 | 1965 - present | Provides searching of entire CAS chemical registry system. User constructs graphic representation of substance and system provides structural diagrams, names, formulas, etc. and ten most recent citations appearing in CHEMICAL ABSTRACTS. |
| CASSI | Chemical Abstracts Service, Columbus, OH | 50,000 | Current | Automated equivalent of CHEMICAL ABSTRACTS SOURCE INDEX. |
| COMPENDEX | Engineering Information, Inc. New York, NY | 1,200,000 | 1970 - present | Computerized equivalent of ENGINEERING INDEX. Covers all aspects of engineering. Includes citations from journals, engineering societies and conferences. |
| Comprehensive Dissertation Index | University Microfilms International, Ann Arbor, MI | 820,000 | 1861 - present | Based on DISSERTATION ABSTRACTS INTERNATIONAL. Contains citations on almost all US dissertations. |
| Conference Papers Index | Cambridge Scientific Abstracts Bethesda, MD | 975,000 | 1973 - present | Provides access to papers presented at international scientific and technical meetings. |
| CRYST (X-Ray Crystallograph Search System) | Crystallograph Data Center Cambridge, England | 28,000 | 1935 - present | Contains both bibliographic and numeric data on crystallography of 38,000 organic compounds. |

Table 3.2 (page 2 of 7)

| Title | Sponsoring Organization | Number of Citations | Dates of Citations | Brief Description |
|---|---|---|---|---|
| DISC | Bibliographic Retrieval Service, Latham, NY | 4,000 | 1982 - present | Covers 10-15 journals in the micro-computer field. Includes hardware, software and management information. |
| DOE Energy | U. S. Department of Energy, Oak Ridge, TN | 1,010,000 | 1974 - present | Covers full spectrum of energy-related topics and corresponds to the printed ENERGY RESEARCH ABSTRACTS. |
| EBIB (Energy Bibliography & Index) | Texas A & M University Library College Station, TX | 20,000 | 1919 - present | Covers all aspects of energy. |
| EIMET (EI Engineering Meetings) | Engineering Information, Inc. New York | 75,000 | 1979 - present | Individual indexing of papers presented at professional meetings. Covers all aspects of engineering. |
| ELCOM (Electronics & Computers) | Cambridge Scientific Abstracts Bethesda, MD | 360,000 | 1977 - present | Covers electronics, electrical circuits, electrical equipment, computing electronics and related applications areas. Publications indexed include journals, books, patents and others. Corresponds to ELECTRONICS AND COMMUNICATION ABSTRACTS AND INFORMATION SYSTEMS ABSTRACTS. |
| Electric Power Database | Electric Power Research Institute, Palo Alto, CA | 9,500 | 1972 - present | Corresponds to DIGEST OF RESEARCH IN THE ELECTRIC UTILITY INDUSTRY. Covers all aspects of electric power generation. |
| ENERGYLINE | Environmental Information Center, Inc., New York | 45,000 | 1971 - present | Computerized form of ENERGY INFORMATION ABSTRACTS. Publications indexed include journals, reports and books. Covers technical, social and policy issues related to energy. |
| ENERGYNET | Environmental Information Center, Inc., New York | 3,000 | current | Computerized directory of individuals, government agencies, companies and energy associations. |
| ENVIROLINE | Environmental Information Center, Inc., New York | 100,000 | 1971 - present | Computer equivalent of ENVIRONMENTAL ABSTRACTS. Includes journal articles, monographs, books, technical reports and government documents. Covers technical, social and legal aspects of the world's environment. |
| Environmental Bibliography | Environmental Studies Institute, Santa Barbara, CA | 225,000 | 1973 - present | Corresponds to printed ENVIRONMENTAL PERIODICALS BIBLIOGRAPHY. Includes 300 periodicals covering all aspect of environment. |
| GEOARCHIVE | Geosystems, London | 450,000 | 1969 - present | Publications indexed include journals, books, conference papers, dissertations and technical reports. Covers all aspects of geological research and includes over 100,000 geological maps. |
| Geomechanics Abstracts | Imperial College of Science and Technology, London | 9,000 | 1977 - present | Computerized form of GEOMECHANICS ABSTRACTS. Covers rock mechanics, soil mechanics and engineering geology. Includes articles, reports and government publications. |

Table 3.2 (page 3 of 7)

| Title | Sponsoring Organization | Number of Citations | Dates of Citations | Brief Description |
|---|---|---|---|---|
| GEOREF | American Geological Institute, Falls Church, VA | 800,000 | 1967 - present | Corresponds to printed BIBLIOGRAPHY AND INDEX OF GEOLOGY. Covers all aspects of geology and related fields. Journals, books, maps, reports and dissertations are indexed. |
| INPADOC | International Patents Documentation Center, Vienna | 110,000 | current | Corresponds to PATENT GAZETTE. Covers recently issued patents in 45 countries. Uses international patent classification system. |
| INSPEC | Institution of Electrical Engineers | 2,100,000 | 1969 - present | Corresponds to SCIENCE ABSTRACTS: PHYSICS ABSTRACTS, ELECTRICAL AND ELECTRONICS ABSTRACTS and COMPUTERS AND CONTROL ABSTRACTS. Covers both research and application areas of physics, computers and electronics. |
| International Software Database | Imprint Editions, Ltd. Fort Collins, CO | 10,000 | current | Corresponds to the MICROCOMPUTER SOFTWARE DIRECTORY and the INTERNATIONAL MINICOMPUTER SOFTWARE DIRECTORY. Covers all aspects of software systems and software implementation. |
| ISI/COMPUMATH | Institute for Scientific Information, Philadelphia, PA | 250,000 | 1976 - present | Covers theroretical and applied mathematics, statistics, computer science and operations research. Includes citations from 300 journals, books and monographs. |
| ISI/ISTP&B (ISI/ Index to Scientific & Technical Proceedings & Books) | Institute for Scientific Information, Philadelphia, PA | 500,000 | 1978 - present | Corresponds to INDEX TO SCIENTIFIC & TECHNICAL PROCEEDINGS. Covers all major scientific and engineering disciplines. |
| ISMEC (Information Service in Mechanical Engineering) | Cambridge Scientific Abstracts Bethesda, MD | 150,000 | 1973 - present | Computerized form of ISMEC BULLETIN. Covers all aspects of mechanical engineering and engineering management. Publications indexed include 250 journals, books and reports. |
| MSSS (Mass Spectral Search System | National Bureau of Standards, Washington, DC | 38,000 | 1966 - present | Covers general area of mass spectrometry. Materials can be retrieved by CAS registry number, molecular formula, molecular weight, etc. |
| MSB (Mass Spectrometry Bulletin) | The Royal Society of Chemistry Nottingham, England | 120,000 | 1966 - present | Covers mass spectrometry as well as related areas of instrumentation, thermodynamics, reaction kinetics, etc. Publications indexed are drawn from journals, books, reports, conference papers and abstracts. |
| MATHFILE | American Mathematical Society, Providence, RI | 350,000 | 1973 - present | Computerized version of MATHEMATICAL REVIEWS. Covers all aspects of mathematical research and applications. Publications indexed include 400 journals. |

Table 3.2 (page 4 of 7)

| Title | Sponsoring Organization | Number of Citations | Dates of Citations | Brief Description |
|---|---|---|---|---|
| METADEX (Metals Abstracts and Alloys Index) | American Society for Metals, Metals Park, OH The Metals Society, London | 500,000 | 1966 - present | Corresponds to printed REVIEW OF METAL LITERATURE, METALS ABSTRACT and ALLOYS INDEX. Covers all aspects of metallurgy. Publications indexed include 1000 journals, books, reports and conference material. |
| MGA (Meteorological and Geoastrophysical Abstracts) | American Meteorological Society, Boston, MA | 100,000 | 1972 - present | Covers meteorology, astrophysics, physical oceanography, hydrology and related environmental sciences. Publications indexed include journals, reports and monographs. |
| Microcomputer Index | Microcomputer Information Services, Santa Clara, CA | 15,000 | 1980 - present | Covers general information, applications, product descriptions and reviews of books and software. |
| Military and Federal Specifications and Standards | Information Handling Services Englewood, CO | 70,000 | current | Computerized form of MILITARY SPECIFICATIONS AND SERVICES, MILITARY STANDARD DRAWINGS and HOT SPECS. Provides specifications, drawings and products/vendors for U. S. government procurements. |
| NASA/RECON (Remote Console) | NASA Scientific and Technical Information Facility, BWI Airport, MD | 2,000,000 | 1967 - present | Publications indexed include government, industry and university reports, journal articles, project records, patents and books. Covers all aspects of science and engineering with an emphasis on aerospace technology. |
| NTIS (National Technical Information Services) | National Technical Information Service, Springfield, VA | 1,000,000 | 1964 - present | Corresponds to printed GOVERNMENT REPORTS ANNOUNCEMENT INDEX. Covers all areas with emphasis on sciences and engineering. Publications indexed are technical reports. |
| NMRLIT | U. S. National Institutes of Health and Prestar Publications, Inc., Bethesda, MD | 35,000 | 1964 - present | Covers all aspects of nuclear magnetic resonance. Publications indexed are principally journals. |
| Nonferrous Metals Abstracts | British Non-Ferrous Metals Technology Center, Wantage, England | 120,000 | 1961 - present | Corresponds to printed BNF ABSTRACTS. Covers all areas of metallurgy related to non-ferrous metals. Publications indexed include journals, monographs, reports, conference proceedings and British patents. |
| PAPERCHEM | The Institute of Paper Chemistry, Appleton, WI | 175,000 | 1968 - present | Corresponds to the ABSTRACT BULLETIN OF THE INSTITUTE OF PAPER CHEMISTRY. Covers all aspects of the papermaking process. |
| PATSEARCH | Pergammon International Information Corporation, McLean, VA | 850,000 | 1971 - present | Covers all U. S. patents since 1971, reissued patents since 1975 and design patents since 1977. |

Table 3.2 (page 5 of 7)

| Title | Sponsoring Organization | Number of Citations | Dates of Citations | Brief Description |
|---|---|---|---|---|
| PIRA Abstracts | The Research Association for the Paper and Board, Printing and Packaging Industries, Leatherhead, England | 65,000 | 1975 - present | Covers scientific and technical literature on products and processes dealing with paper, board, printing and packaging. Publications indexed include journals, reports and monographs. |
| Pollution Abstracts | Cambridge Scientific Abstracts Bethesda, MD | 90,000 | 1970 - present | Covers air and water pollution, environmental quality, solid waste management and pesticides. Includes journal articles, government reports and monographs. |
| Power | U. S. Department of Energy, Washington, DC | 30,000 | 1950 - present | Includes all aspects of energy research and management. Provides access to books and conference proceedings. |
| RAPRA (Rubber and Plastics Research Abstracts) | Rubber and Plastics Research Association of Great Britain, Shrewsbury, England | 200,000 | 1972 - present | Covers polymoric material properties, production and use. Publications indexed are journals and monographs. Includes both trade and scientific/technical information. |
| SAE Abstracts | Society of Automotive Engineers, Warrendale, PA | 11,000 | 1965 - present | Covers all aspects of automobiles and other self-propelled vehicles. Publications indexed consist of Society of Automotive Engineers and International Federation of Automobile Engineering Society papers. |
| Safety | Cambridge Scientific Abstracts Bethesda, MD | 120,000 | 1975 - present | Computerized form of SAFETY SCIENCE ABSTRACTS JOURNAL. Covers topics in safety research including transportation, job place and the environment. Includes journal articles, reports, monographs and patents. |
| SPIN (Searchable Physics Information Notes) | American Institute of Physics, New York | 200,000 | 1975 - present | Covers theoretical and applied physics, astrophysics, astronomy and geophysics. Includes all journals published by the American Institute of Physics, other U. S. physics journals and translations of Russian journals. |
| Standards & Specifications | National Standards Association, Inc. Bethesda, MD | 100,000 | 1950 - present | Indexes standards and specifications developed by government agencies and industrial and professional societies. Data includes testing procedures, performance, terminology, safety, etc. |
| SANSS (Structure & Nomenclature Searching System) | U. S. National Institutes of Health and U. S. Environmental Protection Agency, Bethesda, MD | 230,000 | 1970 - present | Consists of an on-line dictionary of substances appearing in the Toxic Substances Control Act plus other substances in the Chemical Information System. |
| Superindex | Superindex, Inc., Boca Raton, FL | 2,000,000 | 1967 - present | Database consists of entries from back-of-the-book indexes from professional and reference works from twenty-one scientific publishing companies. User can rapidly identify book related to search topic. |

Table 3.2 (page 6 of 7)

| Title | Sponsoring Organization | Number of Citations | Dates of Citations | Brief Description |
|---|---|---|---|---|
| Surface Coatings Abstract | Paint Research Association, Teddington, England | 70,000 | 1976 - present | Covers paints and surface coatings including dyes, resins, solvents, inks, etc. Publications indexed include journals, books, conference proceedings and patents. |
| Textile Technology Digest | Institute of Textile Technology, Charlottesville, VA | 80,000 | 1978 - present | Treats all aspects of processing fibers and textiles. Includes journals, books, theses, patents, etc. |
| THERMO | National Bureau of Standards, Washington, DC | 15,000 | current | Includes numeric thermodynamic data on 15,000 inorganic substances. |
| TRIS (Transportation Research Information Service) | Transportation Research Board, Washington, DC | 175,000 | 1968 - present | Covers all modes of transportation including air, ground and sea. Publications indexed include journals, books, reports and research in-progress. |
| TULSA | University of Tulsa, Tulsa, OK | 324,000 | 1965 - present | Corresponds to the printed PETROLEUM ABSTRACTS. Covers petroleum exploration, drilling, production and related research. Includes journal articles, monographs and patents. |
| USCLASS | Derwent, Inc., McLean, VA | 4,700,000 | 1970 - present | Provides classification numbers for U. S. patents. Includes classifications for patents from 1790 to present. |
| USPA (US Patents Alert) | Derwent, Inc., McLean, VA | 850,000 | 1970 - present | Includes data found on first page of U. S. patent plus patent claims and other data. Documents covered consist of patents, continuations, divisionals, etc. |
| WATERDROP (Distribution Register of Organic Pollutants in Water) | U. S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA | 20,000 | 1970 - present | Provides bibliographic and factual data on organic pollutants in water. |
| Water Resources Abstracts | Water Resources Scientific Information Center, Washington, DC | 175,000 | 1968 - present | Corresponds to printed SELECTED WATER RESOURCES ABSTRACTS. Covers all aspects of water, water management and water use. Publications indexed include journal articles, books, monographs, reports, patents and conference proceedings. |
| WATERNET | American Water Works Association, Washington, DC | 6,500 | 1971 - present | Computerized index of American Water Works Association publications. Covers water management, quality, testing, standards, etc. |
| WELDASEARCH | The Welding Institute, Abington, England | 70,000 | 1967 - present | Covers welding research and technology, metallurgical curing, thermal cutting, etc. Publications indexed include journal articles, books, patents, theses and conference proceedings. |

Table 3.2 (page 7 of 7)

| Title | Sponsoring Organization | Number of Citations | Dates of Citations | Brief Description |
|---|---|---|---|---|
| World Aluminum Abstracts | American Society for Metals, Metals Park, OH | 100,000 | 1968 - present | Covers all aspects of aluminum production, processing and fabrication. |
| World Textiles | Shirley Institute, Manchester, England | 120,000 | 1970 - present | Computerized form of printed WORLD TEXTILES ABSTRACTS. Covers all aspects of fibers and manufacture of textile goods. Includes journals, standards, patents, reports and proceedings. |
| XTAL (Single Crystal Reduction and Search System) | National Bureau of Standards, Washington, DC | 60,000 | current | Corresponds to printed CRYSTAL DATA DETERMINATION TABLES. Provides bibliographic and numeric data on crystal structure and behavior of organic and inorganic compounds. |
| ZLC (Zinc, Lead and Cadmium Abstracts) | Zinc Development Association, London, England | 20,000 | 1970 - present | Computerized form of printed ZINC ABSTRACTS, LEAD ABSTRACTS and CADMIUM ABSTRACTS. Covers chemistry, use and production of zinc, lead and cadmium. Publications indexed include journal articles, technical reports and patents. |

### 3.4 Other Information Sources

In addition to journal articles, books, monographs, conference proceedings and books, expert consultants can also provide valuable information in technology transfer studies. These consultants are generally drawn from universities, industry and government laboratories. Locating and securing the services of a consultant is challenging since consultant databases are either very limited or under initial stages of development. Despite this shortcoming, a number of sources of consultants are available and will be discussed in the following paragraphs.

The largest source of consulting expertise is university faculty. Unfortunately, this is also the most difficult area in which to locate and identify specific individuals. Some general guides are available with the most useful being the 1985 Annual Report [1985] which lists all accredited engineering and engineering technology programs in the U. S. While very general, this document does provide information on areas of expertise within a given university. A number of states, e.g., Florida and Mississippi, are now developing databases of faculty members and these should prove to be useful tools in the future.

Industrial concerns provide a substantial reservoir of scientific and engineering expertise. Unfortunately, many companies discourage and/or prohibit consulting and this limits the utility of this source in third party, technology transfer studies.

Directories of scientific and engineering personnel can be useful sources for identification of consultants. The printed American Men and Women of Science [1979] as well as a host of Who's Who are useful. Note that the American Men and Women of Science is also available as an online database and can be searched for disciplines, geographic location, etc. Directories of consultants and consulting organizations, e.g., Wasserman [1982], are also available.

The formation of the Federal Laboratory Consortium is a recent development and provides the expertise of the federal laboratories to assist in technology transfer. Quoting McNamara [1986]

> "The FLC is a partnership of Federal research and development laboratories and centers. The Consortium originally was established in 1971 by eleven Department of Defense Laboratories as a DoD Consortium. Rapid growth in both numbers and overall acceptance resulted in an expansion in 1974 to include laboratories of all Federal agencies, and the name was changed to the FLC. The Consortium's role is to assist its member laboratories in:
>
> * Development of effective technology transfer methods and mechanisms;
> * Transfer of federally developed technology to domestic public and private organizations;
> * Application of Federal talent, where appropriate, to domestic public and private needs;
> * Establishment of networks with the rest of the scientific community in order to refer requests or engage in cooperative efforts.
>
> Each member laboratory designates a technology transfer representative whose responsiblities are to (a) receive and respond to technical requests, and (b) implement those technology transfer mechanisms that best fit the laboratory's mission."

As can be seen, the FLC is committed to supporting technology transfer activities including the use of federal employees. Appendix 2 lists the various federal laboratories and relevant contact persons. The "Directory of Federal Technology Transfer" [1977] provides some insight into the technical expertise of the various laboratories and agencies.

## 3.5 Summary

Technology transfer studies are built on an existing technology base. This includes input from bibliographic and/or numeric databases and technology experts. This section has described sources of both bibliographic data and consultants. Following sections will provide more detailed descriptions of the use of databases, software tools and problem solving.

## 3.6 References


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<u>Thesaurus of Metallurgical Terms</u>, 5th Edition [1981], American Society for Metals, Metals Park, OH.

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# CHAPTER 4

# SEARCHING MECHANICS

## 4.1 Introduction

As noted in Chapter 3, online bibliographics searching is an important element in technology transfer. As a consequence, this and the following chapter will discuss searching mechanics and search strategy. The basic features of searching were described in Section 3.2.3. While this section illustrated some fundamental features, it did not deal with the capabilities of modern systems. In particular, this chapter will discuss command languages; single-word, multi-word and phrase searches; search logic; searchable fields; and saving and printing search results.

## 4.2 Search Command Languages

Search command languages differ between various online systems. Many search features and system functions are, however, common to all systems even though the language syntax may differ. In an effort to illustrate the capabilities of search systems, the command language for the NASA RECON system, e.g., NASA RECON [1985] and Jack [1982], will be described in some detail. The ensuing search examples will also employ this syntax.

The database command language allows the user to interact with the host computer system. The command normally consists of a command followed by a series of operands, i.e., Command code (Operand 1)/(Operand 2)/(Operand 3)/...

the command code specifies that a certain action be performed on the various operands.

The command codes for the NASA RECON system are described in Table 4.1 and fall into five categories:

i. Search formulation, e.g., QUERY, QUERY ALTER, etc.

ii. Search processes, e.g., EXPAND, SELECT, COMBINE, FREQUENCY and SEARCH EXPRESSION.

iii. Review and/or document search material, e.g., SPECIFY FORMAT, DISPLAY, TYPE, PRINT and BROWSE

iv. User assistance, e.g., HELP, CURRENT and SET STATUS

v. General system functions, e.g., BEGIN, SIGNON, SIGNOFF and END.

Examples of these functions will be described in the following sections.

## 4.3 Online Dictionaries

Database dictionaries and thesauri were previously discussed in Section 3.3.2 and provide valuable assistance in searching. Online dictionaries can be used to help define the search problem, indicate the breadth of coverage of a file or database and narrow or broaden a search.

The NASA RECON protocol for a thesaurus entry uses the Thesaurus EXPAND command

$$\underbrace{\text{EXPAND}}_{\text{command}} \qquad \underbrace{\text{(TS)/(subject term)*(term code)}}_{\text{operands}}$$

where TS denotes the inverted file code for the NASA Thesaurus [1982]. The term codes are NT for narrower, BT for broader, RT for related, UF for used-for and US for use. Figure 4.1 shows the results of

ENTER: EXPAND TS/COMPUTER PROGRAMS

In Figure 4.1 ENTER: is a system prompt, REF denotes the entry or reference number, ST or RT the term type, DESCRIPTOR the term itself, TP the thesaurus type, OCC the number of accessions and TS the thesaurus hierarchial index number.

Figure 4.1 NASA RECON Response to EXPAND TS/COMPUTER PROGRAMS

| REF | DESCRIPTOR | TP | OCC | TS |
|---|---|---|---|---|
| R01 | -ST/COMPUTER PROGRAMS | N | 38727 | 48 |
| R02 | RT/ALGORITHMS | N | 30692 | 21 |
| R03 | RT/APPLICATIONS PROGRAMS (COMPUTERS) | N | 623 | 3 |
| R04 | RT/ASSEMBLY LANGUAGE | N | 247 | 9 |
| R05 | RT/BATCH PROCESSING | N | 359 | 5 |
| R06 | RT/BLOCK DIAGRAMS | N | 4248 | 7 |
| R07 | RT/CODING | N | 3226 | 28 |
| R08 | RT/COMPUTERS | N | 2130 | 163 |
| R09 | RT/DATA CONVERSION ROUTINES | N | 228 | 7 |
| R10 | RT/DATA FLOW ANALYSIS | N | 153 | 7 |
| R11 | RT/DATA PROCESSING | N | 18151 | 74 |
| R12 | RT/DATA TRANSFER (COMPUTERS) | N | 398 | 7 |
| R13 | RT/DIGITAL COMPUTERS | N | 6554 | 120 |
| R14 | RT/ERROR DETECTION CODES | N | 1345 | 13 |
| R15 | RT/FIXED POINT ARITHMETIC | N | 115 | 0 |
| R16 | RT/FLOATING POINT ARITHMETIC | N | 340 | 5 |
| R17 | RT/GODDARD TRAJECTORY DETERMINATION SYSTEM | N | 8 | 11 |
| R18 | RT/INSTRUCTION SETS (COMPUTERS) | N | 189 | 4 |
| R19 | RT/LASER GUIDANCE | N | 75 | 6 |
| R20 | RT/MACHINE TRANSLATION | N | 197 | 6 |
| R21 | RT/MODULARITY | N | 391 | 5 |
| R22 | RT/NASA INTERACTIVE PLANNING SYSTEM | N | 0 | 9 |
| R23 | RT/NUMERICAL CONTROL | N | 3277 | 14 |
| R24 | RT/ON-LINE SYSTEMS | N | 524 | 9 |
| R25 | RT/PROGRAMMED INSTRUCTION | N | 195 | 4 |
| R26 | RT/PROGRAMS | N | 104 | 125 |
| R27 | RT/REPORT GENERATORS | N | 38 | 4 |
| R28 | RT/ROUTINES | N | 60 | 7 |
| R29 | RT/SOFTWARE ENGINEERING | N | 1029 | 0 |
| R30 | RT/SOFTWARE TOOLS | N | 856 | 8 |
| R31 | RT/TRANSLATORS | N | 59 | 6 |
| R32 | RT/USER MANUALS (COMPUTER PROGRAMS) | N | 2679 | 8 |

## 4.4 Single-Term Searches

The most rudimentary search consists of a single-term search. This process uses the command SELECT in the NASA RECON system with the following protocol

$$\underbrace{\text{SELECT}}_{\text{command}} \qquad \underbrace{\begin{array}{l}\text{(Inverted file code/index term) or} \\ \text{(Inverted file code/reference numbers)}\end{array}}_{\text{operands}}$$

For example, a search on the term SOFTWARE would proceed as

ENTER: SELECT ATL/SOFTWARE

and the system will respond with

| SET No | NO. OF REC. | NO. OF OCC. | DESCRIPTION OF SET (+=OR,*=AND,-=NOT) |
|---|---|---|---|
| 1 | 3276 | 3543 | ATL/SOFTWARE |

Note that the inverted file code is a two or three character mnemonic name that represents a searchable field. These differ from file to file and you must consult a user's manual for the proper fields. Searchable fields generally consist of accession number, title, author, journal name, date of publication, language, added terms and/or keywords, abstract, etc. The searchable fields for the various RECON files are shown in Figure 4.2.

As noted in the previous sections, you can normally search for word stems or roots. The protocol varies from system to system. NASA RECON denotes a word root or stem as rootword:. For example, the command sequence

ENTER: SELECT AX/COMPUT:

will produce

| SET No | NO. OF REC. | NO. OF OCC. | DESCRIPTION OF SET (+=OR,*=AND,-=NOT) |
|---|---|---|---|
| 1 | 8718 | 9843 | AX/COMPUTABILITY AX/COMPUTATION ... |

with the number of records related to the root COMPUT. Contrast the number of occurrences with that of COMPUTERS, i.e.,

ENTER: SELECT AX/COMPUTERS } Command

| SET No | NO. OF REC. | NO. OF OCC. | DESCRIPTION OF SET (+=OR,*=AND,-=NOT) |
|---|---|---|---|
| 2 | 4669 | 5627 | AX/COMPUTERS |

Response

A single-term search can also utilize a range function. The NASA RECON protocol takes the form

$$\underbrace{\text{SELECT}}_{\text{command}} \quad \underbrace{\text{(Inverted file code)/(term 1):(term 2)}}_{\text{Operands}}$$

The inverted file code is the same as previously described with term 1 and term 2 being any alphanumeric index terms chosen by the user from the field specified in the file code. All index terms between term 1 and term 2 are SELECTed in the search process. For example

```
ENTER:  SELECT AX/COMPUTERS:COMPUTING                    } Command

SET   NO. OF   NO. OF   DESCRIPTION OF SET
No    REC.     OCC.     (+=OR,*=AND,-=NOT)                 Response
1     11386    13494    AX/COMPUTERS AX/COMPUTING
```

Figure 4.2 Text and Nontext Searchable Fields for NASA RECON Standard Prime Files

**Searchable Field Mnemonics for File Collection 4 or D (Standard Prime Files)**

| Text Searchable Fields | | STAR | RTOP | CPA | R7DCS | ASRDI |
|---|---|---|---|---|---|---|
| Text Fields* | (S) | TX | TX | TX | | ATX |
| Abstract | (SM) | AX | AX | AX | | ABS |
| Analytic Item | (SM) | AI | | AI | | |
| Analytic Note | (SM) | AL | | AL | | |
| Data Summary | (SM) | DS | | | | |
| Use Statement | (SM) | SU | | | | |
| Links | | | | | | LKS |
| All Title Fields** | (S) | ATL | ATL | ATL | ATL | |
| Unclassified Title | (SM) | UTP | UTP | UTP | UTP | |
| Title Supplement | (SM) | TSP | | | | |
| Title Extension | (SM) | TEP | | | | |
| Notation of Content | (SM) | NOC | | NOC | | |

(S): A single word parameter must be used with the mnemonic.

(SM): A single or multiple word parameter can be used with the mnemonic. Multiple words can be either phrase or proximity type entries.

*TX/ATX Includes all fields under Text Fields.

**ATL Includes all fields under All Title Fields.

| Nontext Searchable Fields | TB | OCSTARE | CSTAR | IAA | OSTARE | STAR | RTOP | CPA | ASRDI | ASOR | R&DCS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cont. of Origin | | CI | CI | CI | CI | CI | | | | | |
| DCAF Number | | DC | DC | DC | DC | DC | | | | | |
| Report Number | RN | RN | RN | RN | RN | RN | RN | RN | RN | RN | RN |
| Personal Author | AU | AU | AU | AU | AU | AU | AU | AU | AU | RN | RN |
| Contract Number | CN | CN | CN | CN | CN | CN | | CN | CN | RN | RN |
| Corporate Source | CO | CO | CO | CO | CO | CO | CO | CO | CO | RN | RN |
| Corp Source Text | CT | CT | CT | CT | CT | CT | CT | CT | CT | RN | RN |
| Subject Terms*** | ST | ST | ST | ST | ST | ST | ST | ST | AST | ST | ST |
| Major Terms | MJ | MJ | MJ | MJ | MJ | MJ | MJ | MJ | AMJ | MJ | MJ |
| Minor Terms | MN | MN | MN | MN | MN | MN | | MN | AMN | MN | MN |
| Data Terms | | | | DT | | DT | | | | | |
| Publication Date | | | | | | | | | APD | | |
| ISSN | | | | ISN | | | | | | | |

***ST/AST Includes all fields under Subject Terms.

## 4.5 Proximity Search

Under many circumstances, the searcher may wish to locate material described by words that are close together but not necessarily adjacent. NASA RECON again uses the SELECT command with the operands augmented by word separation information. The protocol consists of

$$\underbrace{\text{SELECT}}_{\text{command}} \qquad \underbrace{\text{(inverted file code)/(term 1)*(+or-)(n)(term 2)}}_{\text{operands}}$$

The inverted file code remains the same. Term 1 and Term 2 are selected by the user. The plus (+) or minus (-) signs indicate whether Term 2 follows (+) or preceeds (-) Term 1. n denotes the number of words separating Term 1 and Term 2. For example,

ENTER: SELECT TX/COMPUTER *+2 PROGRAMS

will provide the number of occurrences of the term PROGRAMS within two words following the term COMPUTER. RECON will produce the following output.

| SET No | NO. OF REC. | NO. OF OCC. | DESCRIPTION OF SET (+=OR,*=AND,-=NOT) |
|---|---|---|---|
| 1 | 3275 | 3496 | TX/COMPUTER *+2 PROGRAMS |

In NASA RECON the proximity index n is limited to values between 1 and 9. Values $1 \le n \le 8$ indicate separation values with n=9 indicating that Term 2 can be any distance from Term 1. With n=9 in the previous example, citations will be selected that contain the two terms regardless of separation. Note that the comparison is made numerically and that the two terms need not be in the same sentence.

## 4.6 Phrase Text Search

Many technical subjects are described by groups of terms or phrases, i.e., turbulent boundary layers, composite materials, heat transfer, etc. The SELECT command can be used for this purpose and

$$\underbrace{\text{SELECT}}_{\text{command}} \qquad \underbrace{\text{(inverted file code)/('phrase')}}_{\text{operand}}$$

The file code is again a mnemonic code representing a field in the inverted files with 'phrase' representing the search string. For example,

```
ENTER: SELECT       AX/'COMPUTER SOFTWARE MAINTENANCE'
```

produces

| SET No | NO. OF REC. | NO. OF OCC. | DESCRIPTION OF SET (+=OR,*=AND,-=NOT) |
|---|---|---|---|
| 1 | 1 | 1 | AX/COMPUTER *+1 SOFTWARE *+1 MAINTENANCE |

## 4.7 Limiting Searches

Online searching can produce copious amounts of output. The large numbers of citations can be reduced to manageable size by narrowing the search or by otherwise limiting the search span, i.e., number of years covered, language, document type, etc. NASA RECON provides two mechanisms for LIMITing the search. The

LIMIT command produces a new reduced citation set from an existing set while the LIMIT ALL command reduces the span of the original search. The latter is preferable if the limits to be employed are absolute, e.g., a search on computer architecture might be limited to 1983-1987 if only recent developments are of interest. On the other hand, after-the-fact span reduction, i.e., LIMIT, is preferred if a simple reduction in the number of citations is desired.

The NASA RECON LIMIT command has the following syntax

$$\underbrace{\text{LIMIT}}_{\text{command}}\quad \underbrace{\text{(set number)/(year)/(accession series)/(range parameter)}}_{\text{operand}}$$

Note that the year, accession series, and range parameter can consist of a set of numbers delimited by commas or a range of numbers delineated by a hyphen or a combination of the two. The range parameter is the last five characters of the RECON accession number.

Consider LIMITing a search on HEAT PIPES. The commands and responses are

```
ENTER: SELECT    AX/'HEAT PIPES'                  }  Command

SET   NO. OF    NO. OF    DESCRIPTION OF SET      )
No    REC.      OCC.      (+=OR,*=AND,-=NOT)      }  Response
1     911       1572      AX/HEAT *+1 PIPES       )
```

```
ENTER: LIMIT   1/80-86                                    }  Command

SET   NO. OF   NO. OF   DESCRIPTION OF SET     )
No    REC.     OCC.     (+=OR,*=AND,-=NOT)     }  Response
2     391      627      LIMIT 1/80-86          )
```

As can be seen, the number of occurrences is substantially reduced.

The search process can be restricted before the fact by using the LIMIT ALL command. The format is similar to LIMIT and

$\underbrace{\text{LIMIT ALL}}_{\text{command}} \quad \underbrace{\text{(year)/(accession series)/(range parameter)}}_{\text{operand}}$

where the operands adhere to the same protocol as the LIMIT command.

The previous search on HEAT PIPES could be formulated using the LIMIT ALL command and

```
ENTER: LIMIT ALL 80-86                                    }  Command

    LIMIT-ALL ACCEPTED 80-86                              }  Response

ENTER: SELECT AX/'HEAT PIPES'                             }  Command

SET   NO. OF   NO. OF   DESCRIPTION OF SET     )
No    REC.     OCC.     (+=OR,*=AND,-=NOT)     }  Response
1     391      627      AX/HEAT *+1 PIPES      )
```

## 4.8 Combining Searches

The most powerful attribute of online bibliographic search systems is the ability to apply Boolean logic to the search process. Once sets have been created using the techniques of Sections 4.3 through 4.7, they can be COMBINEd using the logical operators AND, OR and NOT. The AND function identifies items, i.e., citations, common to two or more sets; the OR function identifies citations in either set 1 or set 2; and the NOT function identifies citations in one set excluding any overlap from the second set. These functions are depicted graphically in Figure 4.3.

NASA RECON implements the logical operations using the COMBINE command. The format follows where

$$\underbrace{\text{COMBINE}}_{\text{command}} \qquad \underbrace{\text{(set number)(AND, OR or NOT)(set number)}}_{\text{operand}}$$

Note that AND can be represented by an asterisk (*), OR by a plus (+) and NOT by a minus (-).

Presume that a technology transfer specialist is interested in obtaining citations related to cooling electronic equipment with heat pipes. The search terms could consist of **cooling and/or heat transfer, electronic equipment and heat pipes**. The search would proceed as follows:

SELECT AX/COOLING    Command

| SET No | NO. OF REC. | NO. OF OCC. | DESCRIPTION OF SET (+=OR,*=AND,-=NOT) | |
|---|---|---|---|---|
| | | | | Response |
| 1 | 12053 | 18132 | AX/COOLING | |

| | | | | |
|---|---|---|---|---|
| SELECT AX/'ELECTRONIC EQUIPMENT' | | | | Command |
| SET | NO. OF | NO. OF | DESCRIPTION OF SET | Response |
| No | REC. | OCC. | (+=OR,*=AND,-=NOT) | |
| 2 | 568 | 632 | AX/ELECTRONIC *+1 EQUIPMENT | |

| | | | | |
|---|---|---|---|---|
| SELECT AX/'HEAT PIPES' | | | | Command |
| SET | NO. OF | NO. OF | DESCRIPTION OF SET | Response |
| No | REC. | OCC. | (+=OR,*=AND,-=NOT) | |
| 3 | 911 | 1572 | AX/HEAT *+1 PIPES | |

| | | | | |
|---|---|---|---|---|
| COMBINE 1 AND 2 AND 3 | | | | Command |
| SET | NO. OF | NO. OF | DESCRIPTION OF SET | Response |
| No | REC. | OCC. | (+=OR,*=AND,-=NOT) | |
| 4 | 8 | 39 | 1 AND 2 AND 3 | |

There are eight citations in the database related to the specified problem. When multiple operators are used in a single expression, the hierarchy of operations is important. NASA RECON processes NOT expressions first, followed by AND expressions and then OR expressions. This precedence can be overridden by using parenthesis. The operation in the innermost set of parenthesis is solved first.

The above example uses the SELECT and COMBINE commands. The two processes can be collapsed using the SELECT EXPRESSION command of Table 4.1.

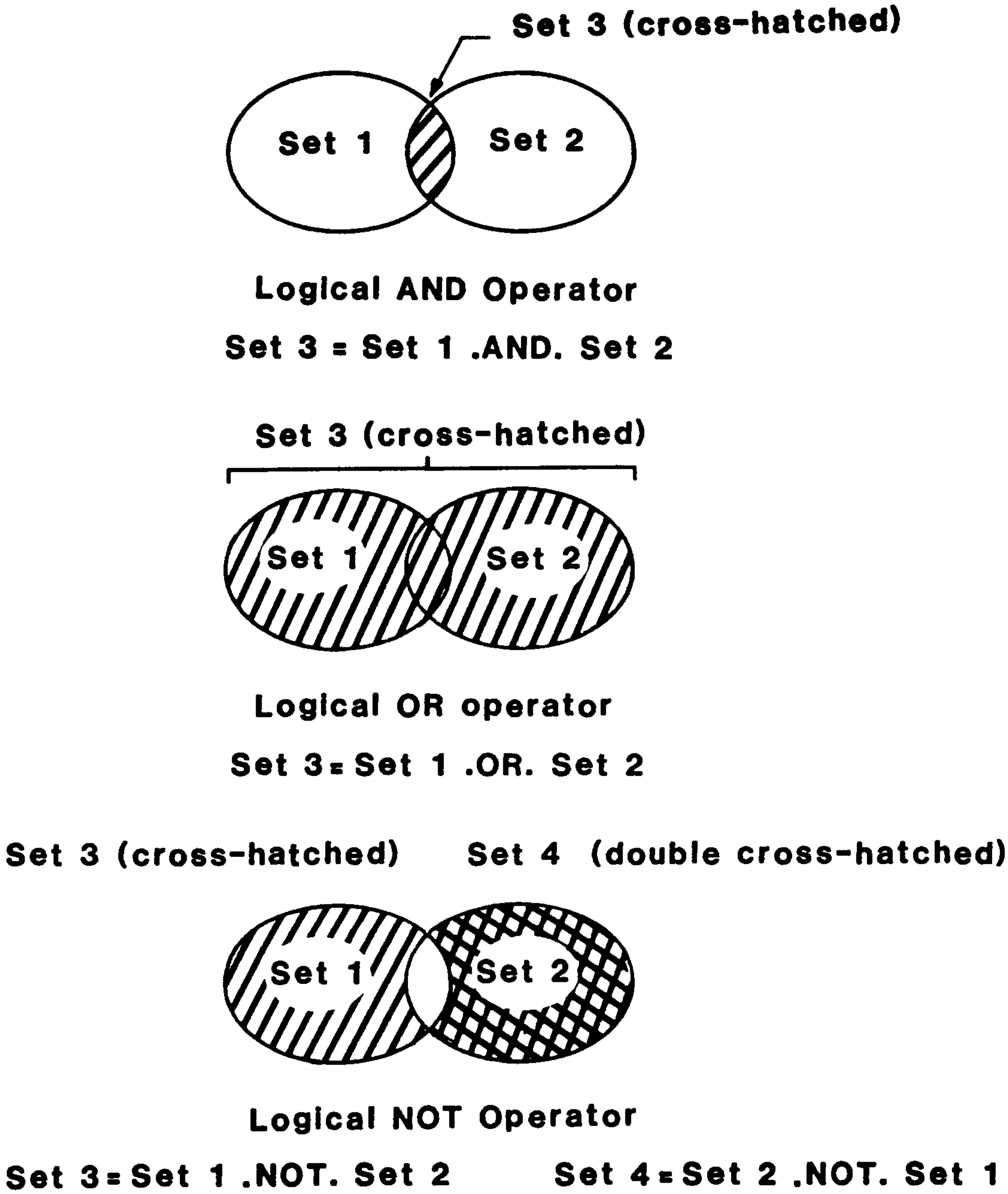


Figure 4.3 Logical Operators AND, OR and NOT

## 4.9 Search Output

Search logic and citations can be viewed using the commands BROWSE, DISPLAY, PRINT and TYPE. The NASA RECON format is the same for all four commands, i.e.,

BROWSE

DISPLAY $\underbrace{\text{(set or accession number)/(format)/(range)}}_{\text{operand}}$

PRINT<br>or<br>TYPE

command

Both BROWSE and DISPLAY are related to terminal and/or microcomputer displays while PRINT and TYPE produce printed copy. The PRINT command produces off-line output while the TYPE command produces output at the user's printer.

The operands consist of the set or accession number, the format code and the range. If a set number is used, all citations for that set are DISPLAYed or PRINTed. An accession number produces a single citation. The format code controls the form of the output. A format code of one produces only accession numbers, two produces full citations, four provides a custom format as controlled by the SPECIFY FORMAT command and six produces full citations excluding the abstracts. The range operand dictates the number of citations printed from a specified set. ALL will print or display all citations, a single number will produce a single citation and two numbers delineated by a hypen, a range of citations.

For example, the command

$$\underbrace{\texttt{PRINT}}_{\text{command}} \qquad \underbrace{\texttt{3/2/4-10}}_{\text{operand}}$$

will result in full citations for items 4 through 10 of set 3.

## 4.10 Saving Search Commands

Search sequences of commands can be saved using the QUERY commands. The process is initiated with the QUERY CREATE command. The commands can be executed as entered and stored or stored only by prefixing each command with an exclamation point (!). If the latter appraoch is used, the command sequence can be stored using QUERY SAVE and then executed using QUERY EXECUTE. Search sequences can be EDITed, DISPLAYed, LISTed, etc. using the QUERY EDIT, QUERY DISPLAY, etc. commands.

The search sequence of Section 4.8 can be executed using the QUERY commands and

```
ENTER:QUERY CREATE                                      Command
BEGIN SEQUENCE CREATION                                 Response
ENTER:!SELECT AX/COOLING                                Command
COMMAND ADDED TO SEQUENCE                               Response
ENTER:!SELECT AX/'ELECTRONIC EQUIPMENT'                 Command
COMMAND ADDED TO SEQUENCE                               Response
ENTER:!SELECT AX/'HEAT PIPES'                           Command
COMMAND ADDED TO SEQUENCE                               Response
ENTER:!COMBINE 1AND2AND3                                Command
COMMAND ADDED TO SEQUENCE                               Response
ENTER:QUERY SAVE HTPC                                   Command
SEQUENCE HTPC    SAVED IN LIBRARY                       Response
ENTER:QUERY EXECUTE HTPC                                Command
HTPC     EXECUTION STARTS
HTPC      :  S  AX/COOLING
  1  12053  18132  AX/COOLING
HTPC      :  S  AX/ELECTRONIC *+1 EQUIPMENT
  2   568    632   AX/ELECTRONIC *+! EQUIPMENT          Response
HTPC      :  S  AX/HEAT *+! PIPES
  3    911   1572  AX/HEAT *+1 PIPES
HTPC      :  C  1AND2AND3
  4     8     39   1 AND 2 AND 3
END SEQUENCE HTPC   EXECUTION
```

## 4.11 References


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Table 4.1 (page 1 of 4)
Command Language for NASA RECON

| COMMAND (ACRONYM) | FUNCTION | OPERANDS | COMMENTS |
|---|---|---|---|
| BROWSE (BR) | Display accession numbers, citations, etc. from user's sets. | (set number)/(format)/(range) | Format code is described under DISPLAY |
| COMBINE (C) | Create new sets from various combinations of existing sets | (set number)(AND(*),OR(+), NOT(-))(set number) | Boolean AND(*) operating on sets A and B yields a new set containing elements which are common to both sets. Boolean OR(+) operating on sets A and B yields a set containing all citations in A or B or both. Boolean NOT(-) operating on sets A and B yields a set containing items in A but not in B. See Section 4.8. Sequence in which operators are processed is in following order unless modified by parenthesis -- root and range, NOT, AND, OR. |
| COMMAND STATUS (CS) | Checks the progress of a transaction after it has been transmitted to RECON | None | |
| CURRENT (CU) | Provides status of a search session | Date, file, kept accessions, limit all, mode, number of sets created, prints requested specify format or time. | |
| DISPLAY (D) | Display accession numbers, citations or parts of citations | (accession or set number)/(format)/(range) | Format codes are: 1 - acession number only, 2 - full citation, 4 - custom format (see SPECIFY FORMAT command) and 6 - full citation excluding abstract. |
| END SEARCH (E) and END SEARCH BY PASS (EB) | Ends a search currently in progress and insures that offline printing will be undertaken. | None | |
| EXPAND (XP or X) | Produces a display of terms that are alpha-numerically adjacent to a specific term. Can produce a display of words related to a specific term, but not similarly spelled. | (file code)/(index term)*(number of terms preceding)*(number of terms following) | Typical file codes are: subject term (ST), author (AU), report number (RN), contract number (CN), corporate source (CO), text (TX or ATL), NASA Thesaurus (TS), etc. Terms EXPANDed can be subsequently expanded using EXX for file code. |
| Thesaurus EXPAND (XP or X) | EXPANDS NASA Thesaurus | TS/(subject term)*(term code) | Term codes are: narrower (NT), broader (BT), related (RT), used-for (UF) and use (US). |
| FREQUENCY (F) | Produces a display of frequency of occurrence for individual terms within an existing set. | (set number)/(ALL,MJ,MN)/(number of citations in set to be used) | ALL, MJ and MN denote all, major terms and minor terms respectively. |

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Table 4.1 (page 2 of 4)
Command Language for NASA RECON

| COMMAND (ACRONYM) | FUNCTION | OPERANDS | COMMENTS |
|---|---|---|---|
| HELP (H) | Produces display of explanatory text related to operand topic. | (command word) | |
| KEEP (K) | Saves a single item or group of items in a set | (accession number),(set number/item number) or (set number/range of item numbers) | Range of item numbers are given as lower number - upper number. |
| LIMIT (L) | Creates new set from an existing set. New set can be limited to specific years, accession series or range parameters. | (set number)/(year)/(accession series)/(range parameter) | Years can consist of a list of years delimited by commas or a range of years joined by hyphens. Range parameter uses the same protocol and consists of the last 5 characters of a NASA RECON accession number. |
| LIMIT ALL (LA) | Limits all subsequent sets related to years, accession series and range parameters. | (year)/(accession series)/(range parameter) | Syntax is the same as LIMIT. |
| LIMIT RELEASE (LR) | Releases LIMIT ALL command | None | |
| ORDER (O) | Permits user to order documents from NASA Scientific and Technical Information Facility. | (set or accession number)/(request type)/(number of copies)/(name and address) | Request type can be either hard copy (HC) or microfiche (MF) |
| PAGE (P) | Pages forward and backward through terminal display. | None | |
| PRINT (PR) | Produces off-line search output. | (set number)/(format)/(range) | Format is the same as DISPLAY. Range can be all citations (ALL), a single citation (X) or a range of citations, lower number - upper number. |
| QUERY (Q) | Creates and permanently saves a search command sequence. | Operand and/or subcommands are listed below. | |
| QUERY ALTER (Q A) | Replaces, line-for-line, commands in sequence being created or modified. | (line number)/(new operand) | New command replaces old command at the specified line number. |
| QUERY CONTINUE (Q CO) | Resumes execution of a paused command sequence. | None | |
| QUERY CREATE (Q CR) | Prepares to create a stored command sequence. | None | |
| QUERY DELETE (Q D) | Deletes specified lines from the sequence being created or edited. | (line number) | Line number or a series of line numbers delimited by commas can be used. |
| QUERY DISPLAY (Q DIS) | Displays selected lines of a stored search sequence. | (sequence name)/(line number or line number range) | Line number range consists of lower line number - upper line number. |

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Table 4.1 (page 3 of 4)
Command Language for NASA RECON

| COMMAND (ACRONYM) | FUNCTION | OPERANDS | COMMENTS |
|---|---|---|---|
| QUERY subcommands continued: | | | |
| QUERY EDIT (Q ED) | Modifies an existing stored sequence. | (sequence name) | |
| QUERY EXECUTE (Q EX) | Executes stored command sequence. | (sequence name) | |
| QUERY LIST (Q L) | Lists command sequence which is either saved or in the work space | (sequence name) | |
| QUERY MEMBER (Q M) | Generates a list of user sequence names for either the requesting user or all RECON users. | (Beginning sequence name (ALL)) | Lists sequence name for all RECON users if ALL is appended in parenthesis. |
| QUERY PAUSE (Q PA) | Interrupts execution of a stored command sequence. | None | |
| QUERY PURGE (Q PU) | Returns user to normal RECON mode with no operand. Removes stored sequence — subject to user verification — if sequence name is furnished. | (sequence name) | |
| QUERY QUIT (Q Q) | Returns user to previous mode. | None | |
| QUERY REPLACE (Q REPLACE) | Replaces a library sequence by a work space sequence. | (sequence name) | |
| QUERY SAVE (Q S) | Workspace command sequence is saved in library under specified sequence name. | (sequence name) | |
| QUERY No-execute (!) | Adds a command to a sequence being created or edited without executing command. | (Any command) | Prefix ! preceeds any RECON command. |
| QUERY No-store (/) | Allows a command to be executed without being stored. | (Any command) | Prefix / preceeds any RECON command. |
| QUERY Set-modification (#) | Modifies set numbers during editing to consecutive numbering. | (set number) | |
| RELEASE (R) | Releases sets from disk storage. | (Set number),(list of set numbers),(range of set numbers) or (list including range) | Lists are delimited by commas with ranges separated by hypens, i.e., lower number — upper number. |

Table 4.1 (page 4 of 4)
Command Language for NASA RECON

| COMMAND (ACRONYM) | FUNCTION | OPERANDS | COMMENTS |
|---|---|---|---|
| SEARCH EXPRESSION (SEARCH or SE) | Enters multiple SELECT and COMBINE commands within a single statement | (One or more arguments with pairs of arguments connected by logical operators) | SEARCH command is used to create and/or combine one or more sets. |
| | | (Field name)/(Term, word or number) | Search specified field for term, word or number. |
| | | (E, R or F reference number) | Search for term displayed by EXPAND or FREQUENCY command. |
| | | (field name)/(root): | Search field for all terms beginning with root. |
| | | (field name)/(item 1:item 2) | Search field for all items alphanumerically between item 1 and item 2. |
| | | (argument or set number), (logical operation), etc. | Search for all records in which arguments occur. |
| SELECT (S) | Creates a set of accessions from one of RECON's inverted files. | (inverted file code)/(index term or reference numbers) | Inverted file code is a mnemonic name for file or field within the file. |
| SET STATUS (SS) | Displays set history including set number, status, document and text occurrence counts and descriptors. | None | |
| SIGNOFF (SIGNOFF) | Disconnects user from central computer. | None | |
| SIGNON (SIGNON) | Checks user identity and connects to central computer. | (identification code) | User identification code (USERID) is assigned by RECON coordinator. |
| SORT (SO) | Modifies order of existing set and creates a new set. | (set number)/(field name, order, field length) | Field name identifies field on which sort will be performed. Order can be ascending (A) or descending (D). Field length specifies number of characters in field to be used in sort. |
| SPECIFY FORMAT (SF) | Allows user to design citation formats for output to be PRINTed, TYPEd or DISPLAYed under format option 4. | (field number or name)(, or ;) (field number or name) | Fields separated by commas will be on same line and fields separated by semi-colons will be on following line. |
| TYPE (T) | Prints accession numbers, citations, etc. on user's printer. | (set number)/(format)/(range) | Syntax same as PRINT. |

# CHAPTER 5

# SEARCH STRATEGY

## 5.1 Introduction

Chapter 4 addresses the mechanics of using online bibliographic database systems with commands, protocals, etc. illustrated by the NASA RECON system. While this is an important element of the "demand-pull" technology transfer process, it is no less important than the formulation of the problem nor the development of the search strategy. Both of these topics will be discussed in the ensuing sections.

As discussed in Section 3.2.4, the technology transfer professional functions as a technical consultant and search intermediary. Since only the client has first-hand knowledge of the problem, the first task of the technology transfer agent is to get a full description of the task. This mandates both a written and verbal description of the problem. Following this step, the agent consults thesauri and papers related to the search topic and constructs a search plan or strategy. The agent should also review the strategy with the client. After development of a mutually acceptable search strategy, the agent carries out the search, analyzes the results and prepares a final report. The search preparation process is shown in Figure 5.1 in flow chart form with the search procedure delineated in Figure 5.2. Table 5.1 lists the relevant factors in the formulation of a search strategy and in the search itself.

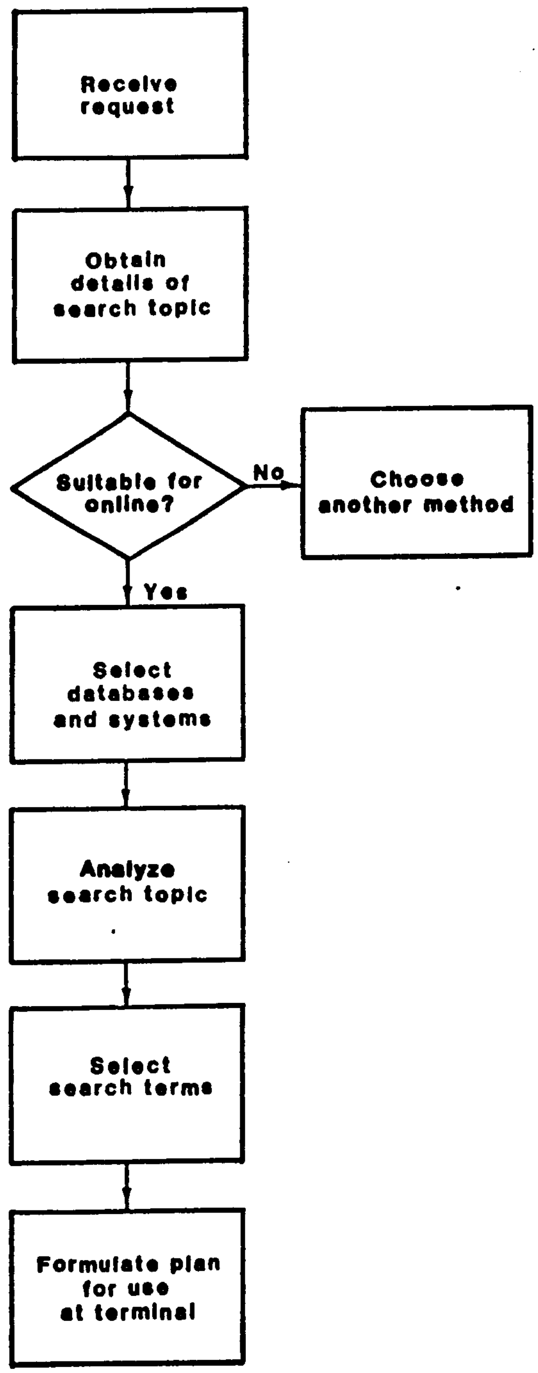


Figure 5.1 Steps in Search Preparation

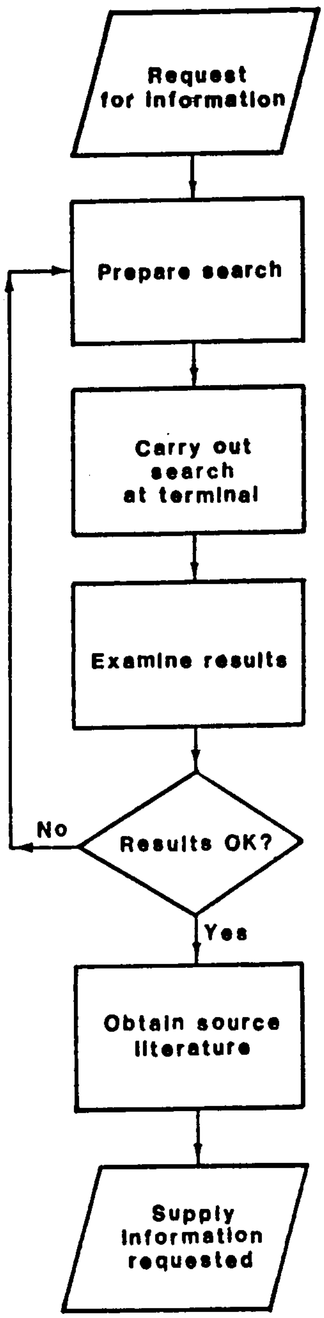


Figure 5.2  Searching Process Steps

TABLE 5.1

FACTORS IN SEARCH STRATEGY FORMULATION AND SEARCHING

SEARCH AIDS

System and database manuals and updates
System and database newsletters
Term frequency lists
Thesauri, dictionaries and classification schemes
Online thesauri and dictionaries
Searching guides

PROBLEM STATEMENT

Brief summary of the problem
List of words and phrases normally used to describe topic
Term specificity
Ordering of terms in logical manner
Details of several relevant recent references
Comprehensiveness of search
Number of citations expected
Limitations by date, language, etc.

DATABASES

Subject and journal coverage
Record content
Indexing attributes
Search comprehensiveness
Cost and accessibility

SYSTEMS

Database coverage
Record content, segmentation, etc. of databases
Search fields
Search devices
Performance, i.e., response rate, offline print distribution, etc.
Print formats
Cost and accessibility

ANALYSIS OF SEARCH TOPIC

Categorize problem into logical components
Exclude unnecesssary concepts
Formulate logical operations
Review analysis with client

TABLE 5.1 (continued)

SELECTION OF SEARCH TERMS

Basis

Search topic and comprehensiveness

Systems and Files

Search devices and indexing policy
Available search fields and default options
Field labels
Controlled and/or index terms
Syntax, stop words and term format
Limiting to priority terms, date, language, files, etc.
Generic term selection
Ambiguity

Terms

Consistency with database
All forms and spellings
All synonymns, broader terms, narrower terms and abbreviations
Root, range and truncation

PLAN THE SEARCH

Know system commands, search devices, protocal and syntax
Prepare the strategy
Plan contingency actions, i.e., search too broad or too narrow
Formulate search save plan

CARRY OUT THE SEARCH

Carry out the search in stages
Use NOT with caution
Avoid using the online system for general exploration
Be expeditious and flexible
Use off-peak times and fastest communication speed
Log off when an impasse is reached or system is performing poorly

C-2

TABLE 5.1 (continued)

NARROW THE SEARCH IF NECESSARY

- Limit search to highly relevant fields
- Limit search to major terms
- Use controlled vocabulary terms
- Decrease use of term truncation
- Reduce the number of ORed terms
- Include additional ANDed terms
- Check for ambiguous terms
- Restrict the use of broad classification codes
- Use specific controlled, natural-langugage phrases, priority labeled terms, etc.
- Limit by date, language, type of literature, file, etc.

BROADEN THE SEARCH IF NECESSARY

- Use free text operators
- Search more databases
- Remove data element restrictions
- Reduce word proximity restrictions
- Reduce the number of ANDed terms
- Increase the number of ORed terms
- Use more truncations
- Search full record and all appropriate files
- Check for the erroneous use of NOTed terms

SEARCH RESULTS

- Use suitable print formats, i.e., accession numbers and titles for online samples and full citations for offline analysis
- Investigate sorting
- Provide a key to abbreviations of journal, conference and organizational names
- Maintain a duplicate record of all search results
- Be prepared to repeat the search if the results are unsatisfactory

## 5.2 Analysis of the Problem

The importance of clearly defining the problem statement cannot be over-emphasized. No one can guarantee success in technology transfer. **A specific problem may not be solvable with existing technology and a research and development program may be required.** In this sense, the lack of available technology to solve the client's problem can be viewed as positive. **Unfortunately, the "no available technology" result can also be the product of a poorly formulated and poorly understood problem statement.** It is essential that the problem formulation be understood and mutually agreeable to both the client and the technology transfer agent (see Section 3.2.4).

The problem definition phase requires close interaction between the client and the agent. The agent should establish a personal contact with the client. The technology transfer professional must understand the topic including all technical details. This includes consulting references on related topics if necessary. The comprehensiveness of the search is an area that should be addressed in the problem statement. In general, one-to-two hundred citations is usually sufficient if the topic is well covered in the literature. On the other hand, a truly exhaustive search may entail thousands of references. It is extremely useful to define the scope of the search at the on-set of the project.

Online searching systems have many advantages, but present one problem -- a large number of databases and citations. As a consequence, one is confronted with the question -- when is enough enough. This decision must be guided by cost, time and search coverage considerations. When the technology transfer agent feels that sample citations are representative and provide adequate topical coverage, the search should be terminated.

## 5.3 Databases and Systems

The selection of the appropriate databases is a function of the search topic and degree of coverage desired, i.e., comprehensiveness. In general, the search should be initiated with the largest and most relevant databases and then extended to the more specialized files if necessary. The latter files tend to produce precision, i.e., a few highly relevant citations, at the expense of breadth, i.e., a large collection of citations with a small subset of relevant references. Database thesauri and dictionaries are invaluable aids in selecting databases. A search should not be undertaken without consulting the appropriate documentation.

The selection of the system and/or database vendor is generally based on cost, comprehensiveness of the individual files, search fields, searching features and user familiarity. Note that database costs are based on both database and communication charges and these are directly proportional to the "connect time", i.e., the time the user is directly connected, online to the system. More expensive database charges can be offset by quicker response times and, thus, databases with the higher unit time cost are not always the most expensive. The breadth of coverage of a system also influences cost. It is usually less expensive to conduct the search on one system rather than on a number of systems. Therefore, a system with greater breadth of coverage and higher charges may be less expensive than using a number of different systems to obtain the same topical coverage. As shown in Section 4.10, a search can be saved. Executing the saved search on more than one database within the same system can also reduce costs. Cost control is an important consideration in online searches. Table 5.2 lists factors which can increase cost effectiveness.

System features, i.e., searchable fields, proximity searches, saving search protocals, etc., will also influence the choice of a database vendor. In many cases, these features are valuable and, as a minimum, may reduce search costs. Last but not least is familiarity of the system to the user -- a technology transfer agent will be most effective using a well-known system.

TABLE 5.2

FACTORS INFLUENCING
ONLINE SEARCH
COST EFFECTIVENESS

- Truncate
- Enter only first part of bound descriptors and commands
- Use monitoring techniques
    - Review query and current search topic for equivalency
    - Assess current plan of anticipated actions for revision
    - Monitor search pattern
        - Eliminate all errors
    - Record search strategies
- Evaluate search results
- Utilize Boolean operations
- Use complete facilities of the command language
- Print records in inexpensive format
- Use least expensive database first
- Expand and select from an expand list

## 5.4 Search Strategy

Once the problem is formulated, the database vendor and files selected, the agent must formulate the search strategy. This consists of determining the keywords, i.e., search terms, and the logical relationships among them. Again, a thesaurus is an invaluable asset in selecting search terms. As shown by the examples of Chapter 4, the search terms frequently have an AND relationship, i.e.,

A .AND. B .AND. C

where A, B and C denote the keywords. The search can be expanded by introducing synonyms or related terms and

(A1.OR.A2.OR.A3...).AND.(B1.OR.B2.OR.B3).AND.(C1.OR.C2.OR.C3...)

Note that adding concepts or keywords narrows the search while deleting keywords broadens the search. This is somewhat at odds with one's preconceptions but is, in fact, correct. The concept is illustrated in Figure 5.3. The keywords A, B and C have an AND relationship with the overlap area denoted by cross-hatching. Deleting A will increase the overlap between B and C, denoted by dots, and thus broaden the search.

A search should be initiated on a broad-basis using as few concepts as possible. Omitting implied concepts will improve the recall - the portion of relevant documents retrieved - without significantly reducing the precision - the proportion of retrieved documents which are relevant. Incorporating a large number of implied concepts will yield a more expensive and time-consuming search without significant improvements in precision.

The agent can hold concepts in reserve and use them to regulate the precision or recall as required. The most effective elements for narrowing a search are years, language or type of article. Note that factors for both broadening and narrowing searches are listed in Table 5.1.

The search terms themselves can be selected from the controlled index terms, i.e., thesaurus, of the database or the uncontrolled terms from titles, abstracts, etc. The controlled terms are generally presented in a hierarchial format and thus related, narrower or broader terms are available from the database dictionary. Furthermore, these terms are generic and, since they are chosen by indexers, usually reflect the more important concepts. The main short-coming of the generic terms is their inflexibility and possible lack of timeliness.

The major advantage of uncontrolled terms is flexibility, i.e., the search can employ the words normally used to describe the problem without recourse to a fixed terminology. The shortcoming of uncontrolled terms is the lack of any generic capacity. As a general rule, searches should utilize index terms wherever possible. If results are unacceptable, then uncontrolled terms can be tried.

As a final point, there is no substitute for experience in search formulation. In some sense, the process can be likened to a black box -- search words in and citations out. The input/output model is far from scientific but, as the searcher gains experience and confidence, the effectiveness of the process will increase substantially.

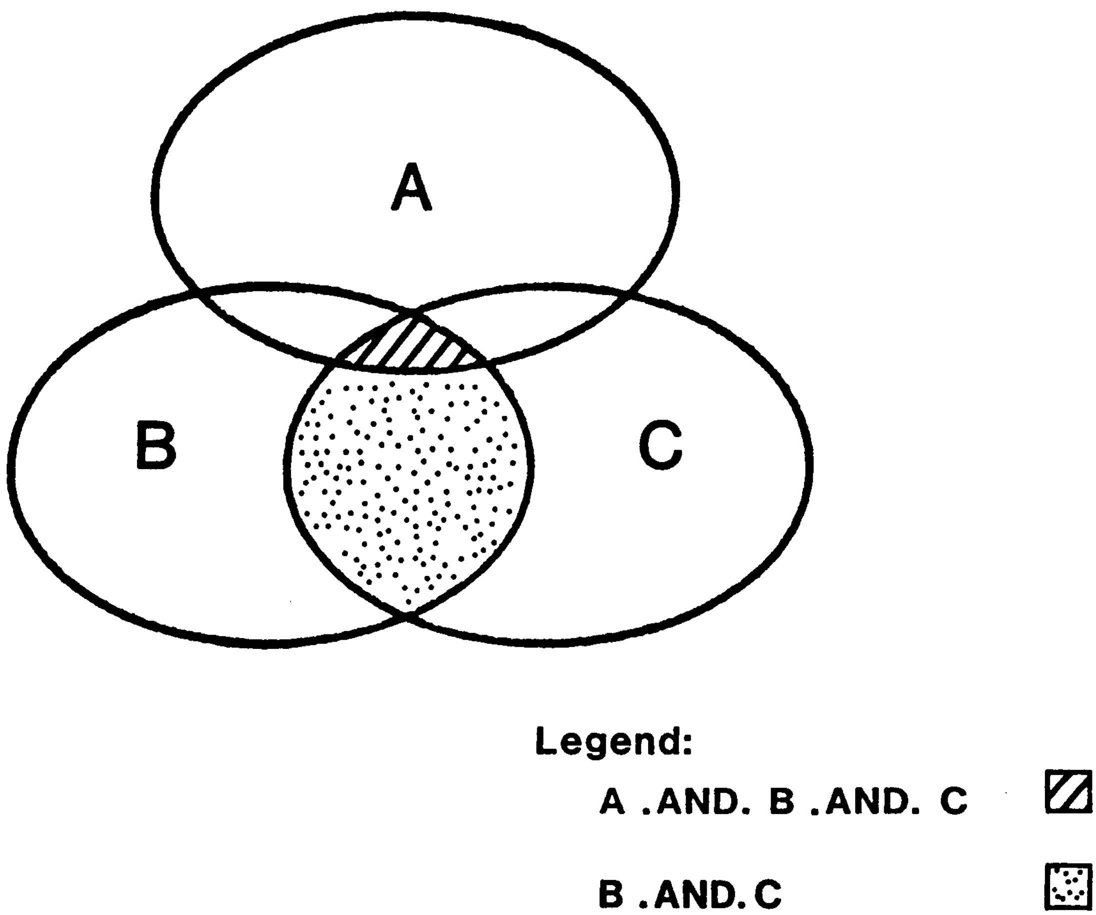


Figure 5.3  Linking Concepts

## 5.5 Workstation Procedures

The searching process is iterative and proceeds in a step-wise fashion (see Figure 5.4). The technology transfer agent enters the search terms and examines first the postings and then some selected titles. The postings are the number of documents containing a specified keyword. At this point in the search, the agent may modify the keywords if too few postings appear or if the titles do not appear to be relevant to the problem statement. If the number of postings is adequate and the titles are appropriate, sample citations are examined. This is another decision point and the search terms must be adjusted if the citations are not relevant. If the examined citations are satisfactory, then the full set of citations can be printed. This completes the process for one database or file.

The above process can be repeated for additional files or databases. If multiple files are to be searched, the search strategy should be saved. Although Figure 5.4 shows the process as continuous, it is best to log off and examine the citations in detail before proceeding to another file. The saved search strategy can be used to repeat the process for as many files as needed.

Remember that in online searching, time is money. Get on and off as rapidly as possible. Do not spend log-on time looking through manuals and thesauri. If you are confused, log-off, review all documentation and try again. It is generally good practice to carry-out a search in stages, review results offline and proceed to the next step.

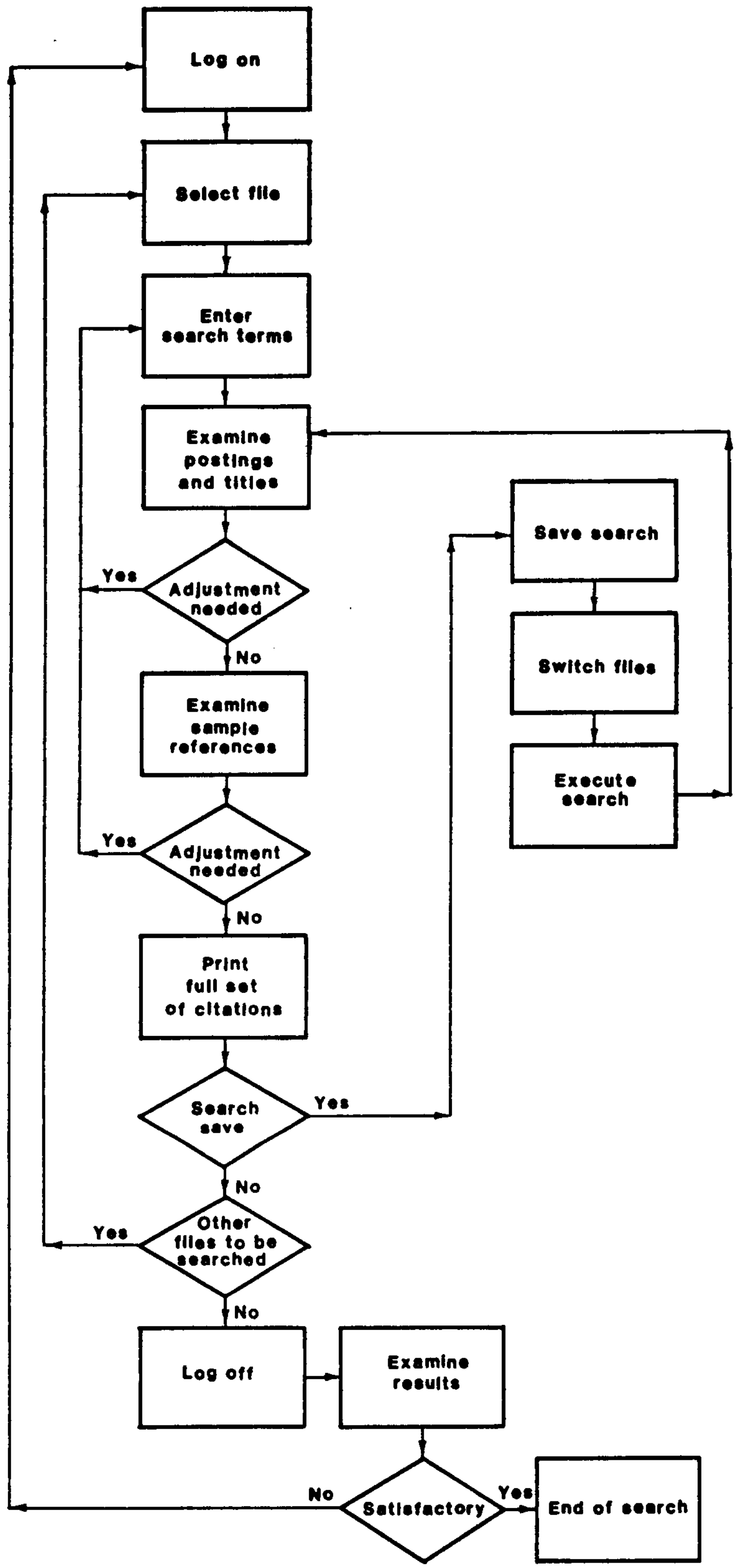


Figure 5.4 The Workstation Process

## 5.6 Search Results

Search results -- as noted in Chapter 4 -- can be printed either online or offline. As will be discussed in Chapters 6 and 7, there is merit to both approaches. Offline printing is less expensive, though it lacks timeliness. Online file transfers are more expensive, but more timely and the results are amenable to further computer analysis. Some online printing is essential to verify the search strategy, reformulate search terms and access the success of the chosen approach. When printing results offline, full citations are desirable. The cost is equivalent to that of titles only, the time required is the same, and the additional information can be used to determine the success of the process.

Analyzing the search results is akin to browsing a library collection. A review of the citations may suggest alternate approaches, a more in-depth examination of one area and key authors in the subject area. Searching is an iterative process and the review of citations may result in another search, more browsing, and the final completion of the search phase of a technology transfer project.

# CHAPTER 6

# SOFTWARE SUPPORT SYSTEMS FOR USE IN TECHNOLOGY TRANSFER STUDIES

## 6.1 Introduction

As reviewed in Chapters 1 and 2, technology transfer can be carried out in a formal manner, i.e., by third-party organizations such as technology transfer agents, or in an informal manner within or external to the technology generating or receiving organization. Typical modes of formal technology transfer can be categorized as: Current awareness searches, retrospective searches, technology assistance programs and industrial application studies. These modes differ in specificity but all include the location of existing technology which is relevant to a specific problem. The technical assistance program and the industrial applications study also encompass the reformulation of the technology to a form understandable to and useable by the technology recipient.

The steps utilized in an industrial applications study are shown in Figure 2.3: locating the technology, analyzing bibliographic information, contacting experts and formulating a final report. The technology acquisition process consists of carrying out online database searches and locating documents relevant to the problem at hand. Since the processes utilized in technology transfer activities of this type are the same regardless of the technology, considerable labor savings can be realized by automating the processes.

Prior to discussing the various software support systems and the automation of the process, it is useful to review the manual mode of operation. Given a well defined problem statement, the technology transfer professional or agent selects a number of databases, becomes familiar with the database thesauri, selects a series of keywords and searches the bibliographic databases on line. Hardcopies of the abstracts are then requested and -- upon receipt -- are analyzed by the agent. At this point, the search can be reinitiated by the agent if the original results failed to locate relevant technology. Note that the analysis process is time-consuming in that the most thoroughly formulated search strategy rarely yields more than about 30-40% relevant abstracts.

Following an analysis of the abstracts, documents are ordered and subsequently analyzed by the agent. Additional expert assistance may be utilized by the agent and the client may be contacted for additional data. Following this technology reformulation step, the final report is prepared and transmitted by the agent to the client. Feedback from the client is solicited by the agent and can be used to determine the efficacy of the study.

The process described in the preceeding paragraphs can be automated using the following scenario. A disk file is established by the agent on a minicomputer or microcomputer for a specific study. The external databases are searched by the agent as described in Chapters 4 and 5 and the agent evaluates abstracts for relevancy either manually and/or by a lexical association software system. Document order forms are prepared by the software system, and the relevant abstracts retained on the disk file. Documents are again evaluated, industrial contacts made, and the final report is prepared by the agent. The final report preparation employs word processing with the text and abstract files merged. The final document can then be printed or transmitted directly to the sponsor over a network or phone line. Finally, a benefit analysis can be merged with the project file.

The software support systems to be employed in the task automation are shown in Figure 6.1. The various modules consist of: Preprocessors for database access, gateway systems, post-processors for citation analysis, a technology expert database, report organization and text processing software, communications software and statistical packages. Most of these functions are reviewed piecemeal in the literature (for additional reading see Appendix 1).

The technology transfer process from a software point-of-view can be approached from a concentrated or distributed perspective. The concentrated concept places all software on one fairly large computer, i.e., a gateway, with database access and all other functions on the same machine. Users access this computer over telephone lines or a communication network. The approach advocated in this work follows a distributed perspective with the computing resources located at the various sites carrying out the technology transfer studies. Computer equipment requirements are substantially reduced, i.e., a microcomputer rather than a minicomputer, since the system supports only one user at a time.

The reasons for the choice of a distributed approach are:

i. The rapid increase in microcomputer capability. A number of manufacturers are now marketing microcomputers having 3 mb of main memory and 40 mb of fixed disk memory in desk-top units.

ii. Cost trends. Microcomputer costs have fallen when compared to communications costs. This factor favors distributed computing over a central, i.e., gateway, computer.

iii. The availability of microcomputer software. Unquestionably, the number of technology transfer oriented computer programs has increased many-fold in the last year.

As a consequence, all the software systems discussed in the following section are operable on a suitably configured microcomputer.

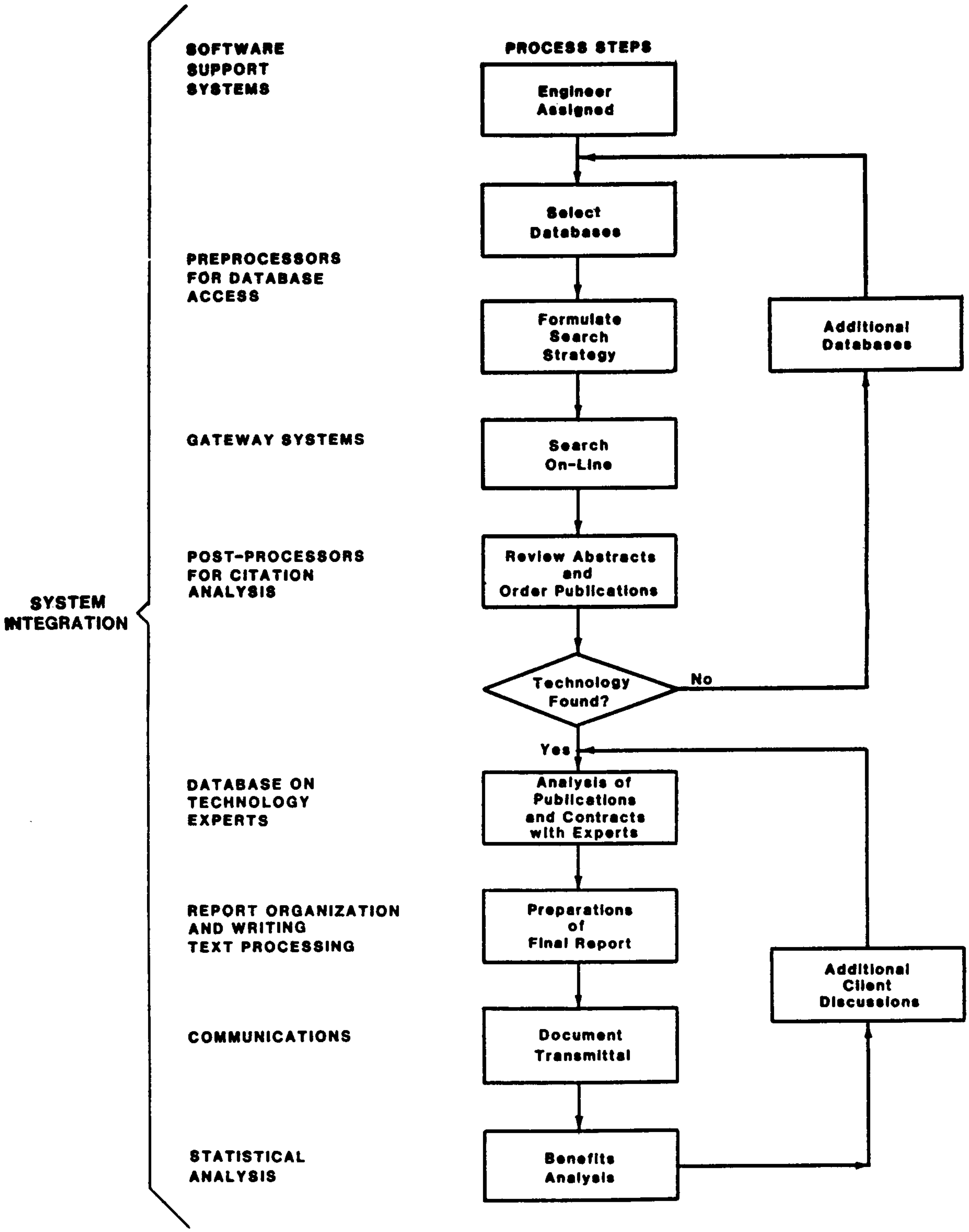


Figure 6.1 Software Support Functions for Technology Transfer Studies

## 6.2 Software Tools

The software support systems described in the ensuing section are all operable on a 16-bit microcomputer utilizing an MS-DOS operating system. This is exemplified by an IBM PC and the minimum computing environment is denoted as an "IBM PC and compatibles".

As noted above, microcomputer software which can assist the searcher is expanding at a rapid rate. Appendix 1 lists a number of papers which review various software systems. A selected subset of the available software packages corresponding to the Software Support Systems of Figure 6.1 are shown in Figure 6.2. Table 6.1 gives a brief description of the functionality of the program along with the minimum operating environment. The software support systems shown are all inclusive in that they will provide sufficient capabilities to fully automate the various tasks of Figure 6.1. The list does not, however, attempt to delineate all possible commercial systems within a functional area. For example, there are probably 50 word processing programs available and a comprehensive list would consume numerous pages. The listed programs should be viewed as typical and capable of supporting the required functionality rather than comprehensive. The user friendliness and documentation varies substantially from one program to another. Since the assessment of program efficacy is frequently a matter of personal preference, no value judgments are offered with regard to the listed programs -- "What's one man's poison is another's meat or drink". Prices on software systems are frequently determined by dealer and educational discounts. As a consequence, pricing information is not included; however, vendors, addresses, and phone numbers for all the listed software systems are included in Section 6.6.

## 6.3 System Integration

The software systems of Figure 6.2 and Table 6.1 are independent programs. The automation process can be significantly improved by integrating the various modules. A memory-partitioning program such as TOPVIEW [1985] or MEMORY/SHIFT [1983] can be used to integrate programs, i.e., a word processing and terminal emulation program. TOPVIEW utilizes a directory of programs and allows two or more programs to reside in memory at once. The program displays are differentiated by using a series of windows. Control and/or operation can be transferred from program to program with a single keystroke. Figure 6.3 shows Display Write 3 [1985] and Personal Communications Manager [1985] operating under TOPVIEW control. The upper left window contains the word processor, the lower central window the communications manager, and the upper right window the TOPVIEW control parameters.

As is shown by the previous example, a communications program (Personal Communications Manager) can be resident in one partition with a word processing program (Display Write-3) in a second partition. The communications program can be connected to an online bibliographic database with the word processing program displaying a search script. The search script is the command and keyword list which represents the search strategy, e.g., see Chapter 5. The searcher can browse and reference the script and then, with the pressing of a key, can return to an interactive searching session. In this way a script can be used in an interactive manner as a readily accessible pattern and guide for conducting the search.

The memory-partitioning program allows the computer-based script to be used in the same manner as a paper-based one, i.e., the script may be consulted simultaneously with the conduct of a search. In addition, the memory-partitioning programs allow the important capability of the copying of commands from the script and their placement directly in the online session.

Many commands used in online search sessions are quite long, and the constituents are acronyms and abbreviations. The capability of copying text from one memory partition into another can reduce the errors in keyboarding as well as the online time required. Note that not all memory-partitioning programs have this cut-and-paste feature.

In addition to the script-viewing partition and the online communications session partition, partitions can be designed for additional copies of the word processing program which can display other files needed in the course of a search. One such file of interest is the session history file. The communications program can record the ongoing session to a disk file. If a partition is allocated to a word processing program which can read the session history file at any time, the searcher can reference past actions. Note that the communications program must have the facility for "closing" the terminal session file at any time so that it may be accessed by the word processing program in the other partition. This use of the session history file would be analogous to the use of the paper record provided by the printing terminal. The file of downloaded citations can also be displayed in this manner.

| SOFTWARE SYSTEMS | FUNCTIONAL AREA |
|---|---|
| IN-SEARCH/PRO-SEARCH<br>MIST +<br>PCCL<br>Smartcom II | Pre-processors for database access |
| Business Computer Network | Gateway Systems |
| SORT-AID<br>NUTSHELL | Post-Processors for Citation Analysis |
| dBASE II | Database programs |
| THINKTANK<br>OFFIX | Report Organization |
| WORDSTAR<br>SELECT WRITE<br>Display Write-3 | Text Processing |
| CONEXUS<br>Personal Communications Manager | Communications |
| STAT-PAK | Statistical Analysis |
| MEMORY/SHIFT<br>TOPVIEW | Integration |

Figure 6.2 Typical Software Packages for Use in Technology Transfer.

Table 6.1 (page 1 of 3)

Descriptions of Some Software Systems Relevant To Technology Transfer Tasks

| Program Title | Description | Environment (1) |
| --- | --- | --- |
| IN-SEARCH PRO-SEARCH | Front-end database searching program. Catalog of all DIALOG databases and resources. Search revision capabilities and keyword high-lighting within each reference. | IBM PC and compatibles. 192 K; two disk drives; smart or acoustic modem. |
| MIST + | Microcomputer communications program. Program contains a full programming language with specifications for telecommunicating, a database system and a text editor. The database can be turned into a full-fledged computer teleconferencing system complete with electronic mail, conferences and on-line databanks. | IBM PC and compatibles. 256 K; two disk drives; hard disk recommended; smart or acoustic modem. |
| PCCL | Menu driven program which allows formulation of a series of command languages. | IBM PC and compatibles. 128 K; one disk drive; smart or acoustic modem. |
| Smartcom II | Menu driven microcomputer communications program. Program establishes and answers computer calls; creates, displays, sends, receives, and stores files; and manages communications parameters. | IBM PC and compatibles. 192 K; one disk drive; smart modem. |
| Business Computer Network | Logs on automatically to a number of on-line information systems. Program captures text on disk, writes messages off-line, sends them on-line and sends sequences to a printer. | IBM PC and compatibles. 128 K; two disk drives; Hayes compatible modem. |

Table 6.1 (page 2 of 3)

| Program Title | Description | Environment |
|---|---|---|
| SORT-AID | Uses lexical association methods to rank abstracts by relevance. | IBM PC/XT or compatibles. 524 K; one disk drive. |
| NUTSHELL | Citation analysis system which allows review, categorization, etc. Records can be indexed by title, author, keywords, etc. | IBM PC or compatibles. 128 K; one disk drive; smart or acoustic modem. |
| dBASE II | Database program which constructs and manipulates numeric and character data. Provides database manipulation directly from a keyboard. Provides capability for user generated menus and application programs. | IBM PC or compatibles. 256 K; two disk drives. |
| THINKTANK | Text processing program oriented toward report organization. Uses outlining technique. | IBM PC/XT or compatibles. 256 K; one disk drive. |
| OFFIX | Personal office system which mimics a file cabinet. Software can search a datafile for up to 10 fields simultaneously and then sort by one of the ten. Can also send information to a screen or printer. | IBM PC/XT or compatibles. 256 K; one disk drive. |
| WORDSTAR | Screen oriented word processing system featuring integrated printing. Displays both initial entry of text and alteration of previously entered text. Includes features for automatic margins, justification and paging. | IBM PC or compatibles. 128 K; one disk drive. |
| SELECT WRITE | Screen oriented word processing system featuring key files for storing frequently used paragraphs and single key insertion into a document. Includes features for automatic margins, justification and paging. | IBM PC or compatibles. 256 K; two disk drives; smart modem. |

Table 6.1 (page 3 of 3)

| Program Title | Description | Environment |
|---|---|---|
| Display Write-3 | Screen oriented word processing system. Includes typical features such as automatic margins, text justification, etc. | IBM PC or compatibles. 128 K; two disk drives. |
| CONEXUS | Communications system providing electronic mail, bulletin boards, tele-conferencing, etc. Includes a password access system. | IBM PC/XT or compatibles. 256 K; two disk drives; smart modem. |
| Personal Communications Manager | Communications and terminal emulation program. Provides limited file transfer and database capabilities. | IBM PC or compatibles. 128 K; two disk drives. |
| STAT-PAK | Performs univariate analysis of data. Includes descriptive statistics, correlation, linear regression, analysis of covariance, goodness of fit and test of independence. | IBM PC or compatibles. 128 K; one disk drive. |
| MEMORY/ SHIFT | Provides capability for simultaneous operation of programs and inter-program data transfers. | IBM PC/XT or compatibles. 128 K; one disk drive. |
| TOPVIEW | Controls selection of terminal emulation, word processing and relevancy ranking programs. Provides capability for simultaneous program operation and inter-program data transfers. | IBM PC/XT or compatibles. 524 K; one disk drive. |

(1) Minimum equipment requirement. 128 K denotes 128 KB of main memory. IBM PC/XT or compatibles denotes micro-computer having 10 MB fixed disk drive. One disk drive denotes 320-360 KB removable disk drive, i.e., floppy disk drive.

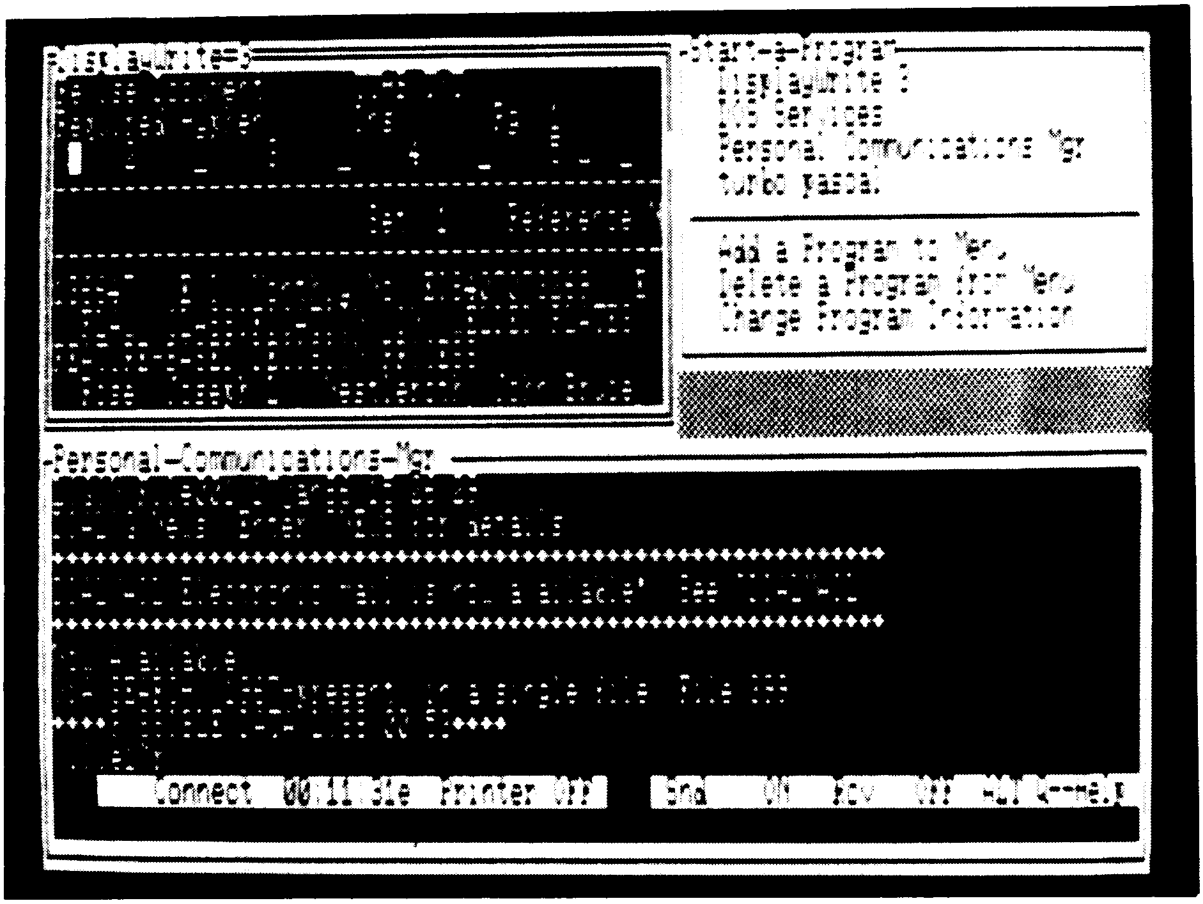


Figure 6.3 A Screen Image Showing a Control, Communications and Wordprocessing Program

## 6.4 Abstract Relevancy

While the programs of Figure 6.2 and Table 6.1 are functionally complete, one issue remains to be resolved -- categorizing abstracts by relevance to the problem statement. As previously noted, the review of abstracts for relevance to the problem statement is a very labor intensive task with 60-70% of the captured abstracts frequently discarded. Consequently, methods to improve search relevance without reducing breadth of coverage can produce significant labor and cost savings. The program SORT-AID has been designed to carry out this task.

The SORT-AID program uses a method for semi-automatic relevance ranking based on lexical association. The index theory is applied to the abstracts which result from a database search. The abstract collection is, thus, homogeneous which accentuates the characteristics of the indexing methods.

The relevance ranking is similar to keyword querying with the keywords selected from lists generated by the indexing algorithms applied to the post-search abstract collection. Two lists of keywords are generated by SORT-AID. The first is based on collection frequency and contains the most frequently used words in the abstracts exclusive of words such as a, an, the, etc. The second set of keywords is based on the signal-to-noise ratio, i.e., a parameter characterizing the global frequency of occurrence divided by a parameter characterizing a global background frequency. The user selects words relevant to the specific problem from the two lists. The relevance score for each citation is then computed using the above user supplied keyword relevancy. The abstracts are then presented in order of relevance to the searcher who can review a fixed number or all of the citations. SORT-AID is discussed in depth from a user's perspective in Chapter 7.

## 6.5 Summary

Technology transfer activities can be carried out in a formal or informal manner. Technology transfer agents employ the formal approach which consists of locating the relevant technology and reformulating it to a form usable by the recipient. The mechanisms employed in the technology transfer activities are more or less the same regardless of the technology. Furthermore, the activities are labor intensive. Significant manhour savings can be realized by automating -- via computer systems -- the technology transfer processes. Software systems are currently available which can yield significant cost and time reductions.

## 6.6 Addresses for Software Vendors

Business Computer Network [1983], P. O. Box 36, 1000 College View Drive, Riverton, WY 82501, 800-446-6255.

CONEXUS [1983], New Era Technologies, Inc., 1252 Columbia Road NW, Washington, DC 20009, 202-887-5440.

dBASE II [1983], Ashton-Tate, 10150 W. Jefferson Blvd., Culver City, CA 90230, 213-204-5570.

Display Write-3 [1985], IBM Corporation, P. O. Box 1328-S, Boca Raton, FL 33432, 305-998-2000.

IN-SEARCH [1983] and PRO-SEARCH [1985], Menlo Corporation, 4633 Old Ironsides-Suite 400, Santa Clara, CA 95050, 408-986-0200.

MEMORY/SHIFT [1983], North American Business Systems, 642 Office Parkway, St. Louis, MO 63141, 800-325-1485.

MIST+ [1984], New Era Technologies, 1252 Columbia Road NW, Washington, DC 20009, 202-887-5440.

NUTSEHLL [1984], Leading Edge Products, 21 Highland Circle, Needham, MA 02194, 800-343-3436.

OFFIX [1983], Emerging Technology Consultants, Inc., 1877 Broadway, Boulder, CO 80302, 303-447-9495.

PCCL [1985], University of Southern Mississippi, College of Science and Technology, Southern Station, Box 5165, Hattiesburg, MS 39406, 601-266-4883.

Personal Communications Manager [1985], IBM Corporation, P. O. Box 1328-S, Boca Raton, FL 33432, 305-998-2000.

SELECT WRITE [1983], Select Information Systems, 919 Sir Francis Drake Blvd., Kentfield, CA 94904, 415-459-4003.

Smartcom II [1984], Hayes Microcomputer Products, Inc., 5923 Peachtree Industrial Blvd., Norcross, GA, 404-449-8791.

SORT-AID [1986], University of Southern Mississippi, College of Science and Technology, Southern Station, Box 5165, Hattiesburg, MS 39406, 601-266-4883.

STAT-PAK [1983], Science Software, RFD 2, Box 63, Nelsonville, OH 45764, 614-753-1397.

THINKTANK [1985], Living Videotext, Inc., 2432 Charleston Road, Mountain View, CA 94043, 415-964-6300.

TOPVIEW [1985], IBM Corporation, P. O. Box 1328-S, Boca Raton, FL 33432, 305-998-2000.

WORDSTAR [1985], Micropro International Corporation, 33 San Pablo Avenue, San Rafael, CA 94903, 415-499-1200.

# CHAPTER 7

# SORT-AID: A POST-PROCESSING SOFTWARE SYSTEM

## 7.1 Introduction

Bibliographic database searching is a key element in technology transfer studies. The downloaded citations and abstracts are analyzed following the search with the post-processing described in Chapter 6. The searcher intends to download only those citations and abstracts that are relevant, but chaff is inevitably present and can be removed only by manual review. The review process can be computer-aided with specialized word processing and data processing routines if the downloaded citations are captured in a computer-readable form. Programs can be written to rapidly display the citations and abstracts to the searcher; to classify the citations; and to support the re-ordering, culling, and electronic review of the downloaded set.

The SORT-AID system is a set of computer programs which executes on IBM PC or compatible personal computer. SORT-AID provides facilities for display, classification, re-ordering, culling and printing of downloaded citation sets.

The software development has been and is sponsored by the NASA Technology Utilization Office. This agency sponsors the Industrial Application Centers (IACs) and the Technology Assistance Centers (TACs), i.e., technology transfer agents. Their primary products are bibliographic database searches with value added in the forms of engineering analysis, report preparation and related in-depth research. A major service performed by the IACs and TACs is the review and classification of downloaded citations. The SORT-AID tool set was designed and constructed specifically for their operations.

## 7.2 The Citation Review Sub-system

Figure 7.1 is a representation of the data flow and component relationships in SORT-AID. Three programs comprise the basic citation manipulation facility. NABST (an acronym for New ABSTract format) executes in a batch mode to format the sequential downloaded set file into a direct access organization. This program must be applied to all downloaded set files, but multiple downloaded sets from diverse database systems may be combined into the same direct access file. Format information for several database systems is available for this program in data tables which are maintained with a text editor (see Table 7.1).

The resulting formatted citation file is used as an input for a second program, called REVIEW because of its function. REVIEW'S role is that of an interactive intermediary between the searcher and the citation file. Citations may be displayed sequentially, forward or backward, or individual citations may be called up by entry of their system-assigned identification number. User interaction with REVIEW is by the keying of commands (see Table 7.2). Comments and classifications may be appended to the citations and used as search arguments. Help texts are available online for all of the commands supported.

Full-text searches on the downloaded citations may be performed on words and phrases. Alternatively, searches of the citation file may be performed with searcher-assigned citation classifications as the argument. Subsets of the citation file, selected by either of the two search modes, may be printed. The response of this program is rapid, owing to the pre-formatting and organization accomplished by NABST and to the inherently superior screen-display capabilities of the personal computer as opposed to remotely accessed systems.

This basic citation manipulation functionality of REVIEW is not markedly different from the search post-processing capabilities described elsewhere (see Appendix 1). It is worth emphasizing that the capabilities of modern, inexpensive personal computers are more than adequate for supporting these types of tasks for most database searchers. Indeed, execution timings on an IBM PC for the compute-intensive programs, NABST and RANK, are comparable to those on a mini-computer. These statements could not have been made a few years ago when an expensive mainframe computer was necessary for this type of text processing application.

A unique aspect of REVIEW is its interface to a relevance ordering component, named RANK. RANK prepares a directory to the citation file. The reviewing program in SORT-AID can use this directory to govern the sequential browsing of citations. Thus, the searcher can view the downloaded file either in the order in which it was captured or in the order indicated by the RANK-supplied directory.

RANK's purpose is to derive an ordering of the citations from the most relevant in the set to the least relevant, with those of intermediate score in decreasing order in between. If the searcher is confident of the RANK-supplied order, only the first or last portion of the file need be reviewed. This can save considerable time when a large number of citations are present.

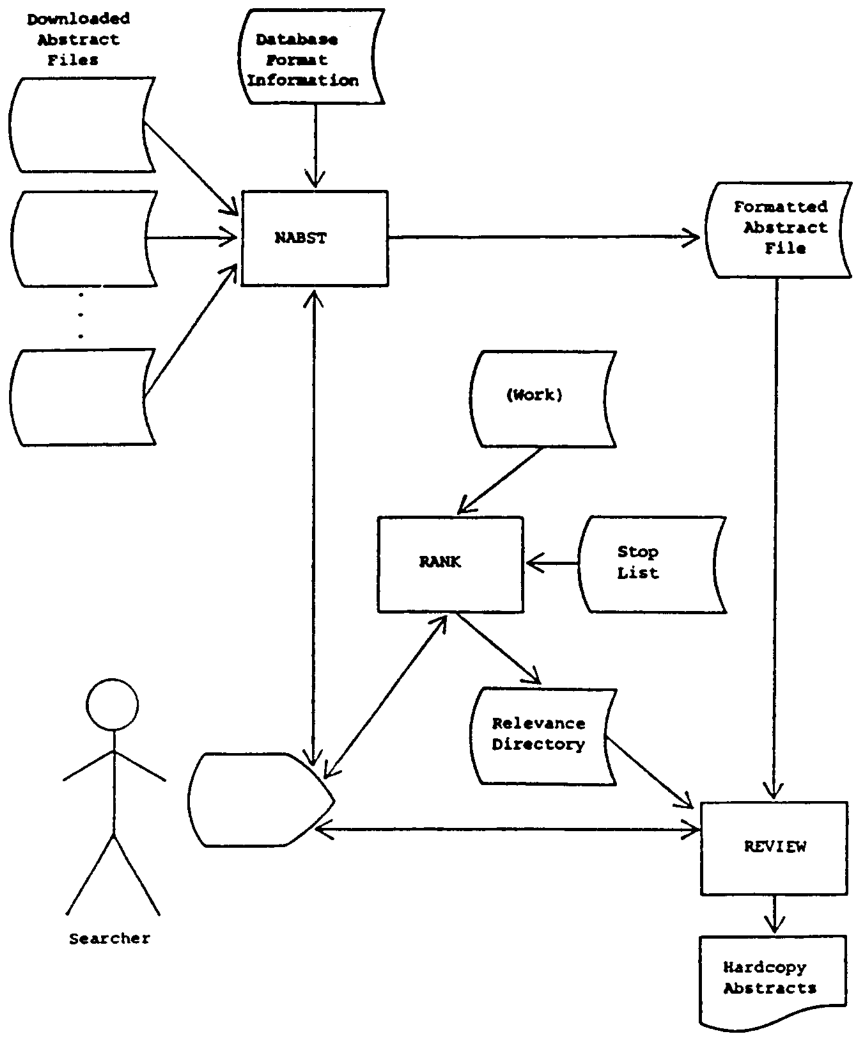


Figure 7.1 System Flow of SORT-AID

TABLE 7.1

## Database Information Files

Below is a sample of the contents of the Database Information Files (stored as DELIM.DAT and SYSTEMS.DAT). These are to be maintained using a text editor.

The record format for both files contains three fields: a single character code for the database system, a 2-digit length specification for the text string following, and the text string field. The fields are separated by a single blank. The text string field in the DELIM.DAT file is a mask for identifying the delimiter the database system places between citations. The "N" is the mask character for any digit. The text string field in the SYSTEMS.DAT file contains the database system name to be printed to hardcopy with the citations.

DELIM.DAT:

```
C 09 NASA/STAC
D 05 N/N/N
N 11 TYPE N/N/N
N 11 TYPE NN/N/N
N 13 BROWSE  N/N/N
N 13 BROWSE NN/N/N
O 03 -N-
O 04 -NN-
O 05 -NNN-
P 06 Item N
```

SYSTEMS.DAT:

```
C 06 ICFAR/
D 07 DIALOG/
E 04 DOE/
N 05 NASA/
O 06 ORBIT/
P 09 PERGAMON/
```

TABLE 7.2

Description of REVIEW Commands

(Abbreviation for the command is in capital letters; system accepts whole command, abbreviation, or [special keys] listed. Command/Function keys are denoted <F1> through <F10>.)

BACkward, B, [-], [left arrow]

The BACkward command is used to browse the citations in backward order. The previous citation will be displayed according to the browsing option in effect (relevance or not; searching on criteria or searching on string.) (See the SEArch CRIteria, MODify SCRiteria, MODify SSTring, SEArch STRing commands.)

DELete

The DELete command will logically remove the viewed citation from the file. If at a later time you wish to restore the citation, use the UNDelete command.

DIR

The DIR ("Directory") command is used to list the sizes (in 1000-character blocks) of the non-deleted citations.

END, EXIT, QUIT, STOP

These commands are used to exit the program and return to DOS. A [control-z] will also stop execution of the REVIEW program and return to DOS.

FORward, F, [+], [right arrow]

The FORward command is used to browse the citations in forward order. The next citation will be displayed according to the browsing option in effect (relevance or not; searching on criteria or searching on string.) (See the SEArch CRIteria, MODify SCRiteria, MODify SSTring, SEArch STRing commands.)

TABLE 7.2 (Continued)

GET, GO, G

The GET command enables the viewing of a citation directly without browsing. REVIEW prompts for a citation number, which is the number corresponding to its position in the physical loading of the file or in the relevance order, if the relevance option is being employed. You may also GET a citation by entering the citation number in response to the "REVIEW>" prompt.

Example: "REVIEW> 3 <RETURN>" will display the third citation loaded in the file by NABST for physical reviewing or the third most relevant if the relevance option is being used.

HElp, [?], <F1>

Help may only be invoked at the "REVIEW>" or "Topic?" prompts. When you receive the "Topic?" prompt, enter the command of interest or <RETURN> or [control-z] to exit help.

Help is available for these commands:

| | | | | |
|---|---|---|---|---|
| + | - | ? | B | BACKWARD |
| DELETE | DIR | END | EXIT | F |
| FORWARD | G | GET | GO | HELP |
| MC | MODIFY | MP | MS | N |
| NEXT | P | PA | PN | PREVIOUS |
| PRINT | QUIT | SC | SCRITERIA | SEARCH |
| SET | SHOW | SP | SS | SSTRING |
| STOP | TOP | UNDELETE | ^ | |

MODify PARameters, MP

The MODify PARAmeters command is used to modify:

1) screen parameters
   a) screen width
   b) screen length
2) print page width

MODify SCRiteria, MC, <F6>

The MODify SCRiteria command is used to modify the search criteria string used with the SEArch CRIteria command.

TABLE 7.2 (Continued)

MODify SSTring, MS, <F8>

The MODify SSTring command is used to modify the arbitrary whole text search string used with the SEArch STRing command.

NEXt, N, [down arrow]

The NEXt command will cause the next, physically stored or relevant ordered, non-deleted citation to be displayed, depending on the ordering option chosen when REVIEW was invoked. No searching is performed.

PREVious, P, [up error]

The PREVious command will cause the previous, physically stored or relevant ordered, non-deleted citation to be displayed, depending on the ordering option chosen when REVIEW was invoked. No searching is performed.

PRInt, PN, <F3>

This command causes individual citations (by number) to be written to a disk file. You are prompted for the output disk file name and whether you wish to start a new file or append to an old one. You will then be prompted for the citation numbers (one at a time). To exit the PRInt command enter a <RETURN> to the citation number prompt.

PRInt ALL, PA, <F4>

This command causes all of the citations qualified by the current search option in effect (criteria or text string) to be written to a disk file. You are prompted for the output file name and whether you wish to start a new file or append to an old one.

SEArch CRIteria, SCRiteria, SC, <F9>

This command causes browsing to be governed by the searcher-specified criteria string. Only the citations which have a searcher-specified criteria field matching this criteria string will be displayed. (See the MODify SCRiteria and the SET commands). Browsing will be in physical or relevance order, depending on the option chosen when REVIEW was invoked.

TABLE 7.2 (Continued)

SEArch STRing, SSTring, SS, <F10>

This command causes browsing to be governed by the searcher-specified whole text search string. Only the citations which have this whole text string in them will be displayed. (See the MODify SSTring command.) Browsing will be in physical or relevance order, depending on the option chosen when REVIEW was invoked.

SET, <F2>

The SET command is used to change the displayed citation's searcher-supplied criteria string. Multiple criteria may be entered separated by commas.

SHow PARameters, SP

This command will cause the screen and print page width parameters to be displayed. (See the MOD PARameters command.)

SHOw SCRiteria, <F5>

This command will cause the display of the current search cirteria string.

SHOw SSTring, <F7>

This command will cause the display of the current whole text search string.

TOP, [^]

This command causes the currently displayed citation to be re-displayed from the beginning.

UNDelete

This command restores access to a DELeted citation.

## 7.3 The Relevance Determination Sub-system

The use of software systems as search intermediaries has been spurred by the development of microcomputers and the growth of artificial intelligence and/or expert programs. The RANK program provides a semi-automatic method of relevance-ordering, i.e., precision increasing, using lexical association techniques. RANK automatically indexes the downloaded set of criteria and allows the searcher to re-pose the original query using the lexical association, generated keyword index as a source for search terms. This stepwise iteration of the indexing and searching process can result in more powerful discrimination within the set of citations than was originally possible when those citations were dispersed as a small proportion of the complete database.

The theory of automatic indexing is well-described in the literature (Salton, 1975). RANK employs two lexical association methods, i.e., collection frequency and signal-noise. The searcher can select which of these methods will be used in a given application run of RANK. Theory suggests that collection frequency is most appropriate when high recall is desired and signal-noise when the primary objective of search querying is high precision.

The collection frequency method selects words to use as index terms on the criteria of most occurrences in the complete corpus of citations to be indexed. Thus, the words selected to be keywords are those which appear most frequently in the downloaded citation set. The signal-noise method selects keywords differently. The terms used frequently in a small number of the citations are selected over those terms used uniformly throughout the set. A stop list eliminates the common and content-less words such as a, an, the, or the code words used to format citations by the database services from the index. Table 7.3 provides an example of a stop list, which is maintained with a text editor. RANK will also prompt the user for the minimum and maximum word size to be considered for index terms.

After the index of keywords is generated, the searcher in effect repeats the querying process. In this phase, RANK displays all of the words in the index, from the one with the highest score -- as calculated by the automatic method in RANK -- to the one with the lowest. The searcher can move the cursor to select one of the displayed terms and enter a positive or negative integer relevance value for the term selected. If a value is not applied to a word in this manner, a zero value is assumed. This method of selecting keywords for querying would be impractical for the database as a whole, but is quite workable for the smaller downloaded set.

Instead of returning a subset of the database as in a conventional query, RANK develops an ordering for the downloaded set. Relevance values applied by the searcher to the index terms are used by RANK to compute relevance scores for each of the citations in the downloaded set. Citations containing a word with a non-zero relevance value have their scores modified by the amount of the value. High positive values cause citations containing the word to get a higher score. High negative values cause citations containing the word to get a lower score. Zero values do not affect the calculation. The citation scores calculated in this manner are sorted into decreasing order and then used to build the directory which is passed to SORT-AID's review function.

TABLE 7.3

**Stop List File**

Below is an example of the Stop List File, which is stored as STOP.TXT. This file is to be maintained using a text editor.

The stop list is used without consideration of the case (upper/lower) of the letters, so that the inclusion of the word "an" causes "an", "An", "aN', and "AN" to be removed from consideration as index terms by RANK. When any modifications are made to the file STOP.TXT, the program SORTSTOP must be run. This program puts the stop list in a form mandatory for RANK. SORTSTOP uses the file STOP.TXT as input and creates a new STOP.DAT file for RANK.

```
STOP.TXT:          a                  there
                   an                 system
                   the                an
                   and                ti
                   when               au
                   where              so
                   how                cc
                   what               ...
```

## 7.4 Example SORT-AID Session

Figures 7.2 through 7.4 contain several screen images from a session with SORT-AID. These screen images are numbered and are arranged in a typical order of use.

Figure 7.2, Screen 1, shows an execution of the NABST program. The searcher is prompted for the name of the downloaded citation file which is to be added to the formatted citation file. Downloaded files from several different database systems may be merged into one formatted citation file by successive invocations of the NABST program, as shown in the example.

Downloaded citation files are named according to a convention described in the NABST display. This convention associates file names with project numbers which can be used for identifying reports and billing information. A formatted citation file is created for each project number.

Figure 7.3, Screen 2, shows a use of the RANK relevance determination sub-system. Option zero (0) stops execution of RANK and returns the user to the operating system. Option one (1) should be chosen when RANK is used to analyze citations for the first time. This option creates an index for querying. This index is developed using files prepared by the NABST program. NABST can be directed to forgo creating these files if RANK is not used. Option two (2) uses the previously created index for a new query. This option can save some processing time by allowing the searcher to reformulate a relevance determination user-supplied value assignment without re-computing the keywords. Option three (3) creates a completely new index for querying from the work files produced by RANK in option one (1). Option three (3) should be chosen when a different automatic indexing method is desired for a set of citations that have previously been analyzed by RANK .

RANK can be executed in a batch mode. Under batch mode, only options one and three may be used. After RANK has completed execution under batch mode, RANK should be run again with option two, which will query the user for relevance values for the index terms and compute the relevance scores.

The searcher may choose the automatic indexing method used by RANK. When the index is prepared, the terms are displayed in order by decreasing calculated weight as shown in Figure 7.4, Screen 3. The searcher now enters relevance values for use in calculating the relevance scores for the citations. The searcher can move the cursor to select one of the displayed terms, using the letter U for up and D for down. When the cursor is positioned on the desired relevance value, the user then presses the <RETURN> key. RANK will prompt the user at the bottom of the screen for the new relevance value. This value must be an integer between -9999 and 9999, inclusive. When all the modifications to the relevance values have been made, the user must press the letter Q to terminate modifications and continue the ranking process.

RANK uses the searcher-supplied relevance values to prepare a dictionary which contains a relevance order assignment for the formatted citation file. Figure 7.5, Screen 4, shows an invocation of the REVIEW program. The searcher selects the RANK-supplied directory for browsing in relevance order or the original directory for browsing in the as-loaded order.

Screen 4 contains an instance of the issuance of the HELP command to REVIEW. Commands are given to REVIEW in response to the "REVIEW>" prompt. This is a complete HELP facility patterned after commonly seen timesharing HELP systems. All of the supported commands are explained with HELP texts: see Table 7.2 for a list of the commands and brief explanations.

Figure 7.6, Screen 5, contains a REVIEW display of a citation. The top line of the display shows the relative relevance position of the citation in the formatted file and its relative physical position.

The second line of the REVIEW citation display shows the searcher-supplied criteria text for this citation. This is the field where the searcher may store classification information or other notes. This criteria field is examined by REVIEW in one of its browsing and printing modes. An option of the SEARCH command is available to browse the citations in such a manner that only citations with a certain criterion are displayed. This is useful when the searcher wants to see only the citations that have been classified in a certain way. An option of the PRINT command may be used to print only the citations with a certain searcher-supplied classification. This is useful for report preparation and for client presentation of the results of the searches.

There are also options in the SEARCH and PRINT commands for similar facilities governed by the presence of specified text strings in the text of the citation. This capability is useful for browsing the works of a single author, for example. The details of the use of these browsing (SEArching) commands and printing (PRInting) commands are explained in Table 7.2.

Screen 1:

Your downloaded citation file should be named:

Project number (up to 5 chars)

followed by

"."

followed by

one character which identifies the database
(such as O for ORBIT or D for DIALOG)

followed by

two characters which identify the file.

Example: I998.D02 which means:

Project number is "I998", and the file is downloaded from DIALOG, and its identification is "02".

Figure 7.2. Session With SORT-AID.
Screen 1.

```
------------------------------------------------------------------
>NABST
                                        Press <ESC> to Exit

What is the project number:                           > I998

What is the extension of the input file?              > D02

What identifying text would you like
 appended to citation printouts
 (max 20 chars)?                                  > 05/13/86

Is this the first file processed for this
 project number (Y/N)?                                > Y

Do you wish to create files for later use
 of RANK (Y/N)?                                       > Y

> NABST
                                        Press <ESC> To Exit


What is the project numer?                            > I998

What is the extension of the input file?              > 001

What identifying text would you like
 appended to citation printouts
 (max 20 chars)?                                  > 06/10/86

Is this the first file processed for this
 project number (Y/N)?                                > N

Do you wish to create files for later use
 of RANK (Y/N)?                                       > Y
------------------------------------------------------------------
```

Figure 7.2 (Continued)

Screen 2:

```
--------------------------------------------------------------------
>RANK

What is the project number to use?               > 1998

                         RANK OPTIONS MENU

     0. -- Stop program and return to DOS
     1. -- Create index and query
     2. -- New query with existing keyword index
     3. -- Create NEW index and query with existing RANK
           work files

Enter option (0-3)                                            > 1

What is the minimum word length of index terms?
Please enter a length between 1 and 30                        > 3

What is the maximum word length of index terms?
Please enter a length between 3 and 30                        > 20

                 RANK AUTOMATIC INDEXING METHOD MENU

     0. -- Stop program and return to DOS
     1. -- Compute word weights using frequency of
           occurrence
     2. -- Compute word weights using signal-to-noise
           ratio
     3. -- Compute word weights using binary frequency
           of occurrence

Enter option (0-3)                                            > 1
--------------------------------------------------------------------
```

Figure 7.3. Session With SORT-AID.
Screen 2.

**Screen 3:**

```
--------------------------------------------------------------------
RANK QUERY DISPLAY                         Press <ESC><ESC> when done

 User-Supplied               Index Term                  Calculated
Relevance Value                                            Weight

      10                     HYDROSTATIC                   18.1660
       0                     PRESSURE                      18.1660
      10                     TRANSMISSION                  15.1383
       0                     HYDRAULIC                     12.9843
       0                     POWER                         12.1660
      20                     FLUID                         11.5416
       0                     CONCEPT                        9.0830
       0                     TEMPERATURE                    9.0830
       0                     SUPERSONIC                     6.0830
     -10                     RUSSIAN                        5.0416
       0                     LUBRICITY                      4.0553

Enter value for LUBRICITY [10]                          > 5
--------------------------------------------------------------------
```

Figure 7.4. Session With SORT-AID.
Screen 3.

Screen 4:

```
-----------------------------------------------------------------
> REVIEW


What project number do you wish to review?              > I998

Do you want to use the relevance directory
 (Y/N)?                                                 > Y


REVIEW>                                                 > HELP


Help may only be invoked at the "REVIEW>" or
"Topic?" prompts.  To invoke help, respond to the
prompt with "HElp", <F1>, or "?".  To exit help,
enter a <RETURN> or a "control z" in response to
the "Topic?" prompt.


Help is available for these commands:


     +           -           ?            B              BACKWARD
     DELETE      DIR         END          EXIT           F
     FORWARD     G           GET          GO             HELP
     MC          MODIFY      MP           MS             N
     NEXT        P           PA           PN             PREVIOUS
     PRINT       QUIT        SC           SCRITERIA      SEARCH
     SET         SHOW        SP           SS             SSTRING
     STOP        TOP         UNDELETE     ^


Topic?
-----------------------------------------------------------------
```

Figure 7.5. Session With SORT-AID.
Screen 4.

```
Screen 5:
-----------------------------------------------------------------
relevance #     2    --    physical #     45
Searcher-supplied citation criteria:  <none
supplied>

AN   - 670697
TI   - Fluids for High-Pressure Industrial Hydraulic
       Systems
AU   - Hanly, F. J. (Chevron Res. Co.)
SO   - Society of Automotive Engineers Technical
       Paper No. 670697
IT   - CONTAMINATION; HYDRAULIC FLUDIS; PUMPS

AB   -    for industrial (nonaerospace)
       applications, hydraulic system pressures can
       be  increased to the "high pressure"  (2000-
       5000  psi) or even the "very high  pressure"
       range    (5000-10,000    psi)    with    fluids
       available currently.  Fluid properties that
       must  be  considered for high  pressure  use
       are:  lubricity,  antiwear,  bulk  modulus,
       cleanliness,    vaporization    temperature,
       stability, and seal compatibility.  For fire
       resistance,  extreme  low   temperature  and
       extreme  high   temperature  synthetics  are
       required.   High  quality,   petroleum-base
       fluids have the greatest number of  relative
       advantages    for   regular  high   pressure
       hydraulic service.

<Press RETURN for more of this citation or enter
command>

REVIEW>
-----------------------------------------------------------------
```

Figure 7.6. Session With SORT-AID.
Screen 5.

## 7.5 Summary

The basic citation manipulation and reviewing capability afforded by SORT-AID has been enthusiastically received by the user community. Such tools as this are relatively inexpensive to implement and increase the productivity and effectiveness of searchers.

Such a component as RANK is a logical extension of the basic citation manipulation capability. Re-indexing and re-searching is a useful and powerful approach for ordering citations by relevance. This re-index and re-search strategy is prohibitively expensive on time-sharing computers but is quite practical using microcomputers.

Effective and efficient data processing techniques such as are exhibited by SORT-AID have great pay-off in proportion to their cost, especially in this age of the personal computer. The considerable attention currently paid to artificial intelligence technology can obscure this fact. The true value of automating intellectual tasks is as an aid to the human worker -- not as a replacement.

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CHAPTER 8

# REFORMATTING AVAILABLE TECHNOLOGY FOR THE END USER

## 8.1 Introduction

Many technology transfer tasks are largely independent of the technology and/or the engineering and scientific discipline. While specific technological expertise may be helpful in bibliographic database searching, it is not absolutely essential. As noted in Section 3.2.4, the requirements of searching have led to the development of search intermediaries. These individuals, working in concert with the technology experts, form the technology transfer team.

While the searching process is technology independent, the reformatting of the data unearthed in the search is discipline specific. The analysis of publications and the customizing of available data to meet the needs of the client requires an in-depth knowledge of the specific technology and the targeted application. It is obviously impossible to deal with reformatting data for all possible technologies and the following sections will present some general guidelines along with selected examples. The discussion will focus on quantifiable data although engineering judgments are important elements in technology transfer studies. The latter require substantial practical experience.

As noted above, the following sections will deal with reformulating, i.e., customizing, quantified data for the end user. The topics to be discussed consist of data relevance, data reliability, data reformulation and data presentation formats. While by no means all inclusive, these topics provide a basic foundation for technology transformation.

## 8.2 Relevance of the Data to the Problem Statement

Following the search and analysis processes of Chapters 5, 6 and 7, publications are ordered and reviewed. While one of these documents may solve the client's problem, this is rarely the case. In general, data from many publications must be combined and pieced together to develop the problem solution. Both specific measurements and generalizations can be useful in the reformatting phase. Since the data is usually extended from the initial environment of the tests, generalizations can provide insight into extrapolations and differing conditions. The extension of data developed in one context to a different environment requires sound engineering judgment. This judgment can be based in part on the data source and recommendations of the original developer, assumptions employed in the original test program, and any obvious data limitations. Reviewing the collected data with the client can also prove useful. The client may be able to provide guidance regarding data relevance.

## 8.3 Data Reliability

### 8.3.1 Data Uncertainty

When parameters are measured, the measurement is always subject to errors or inaccuracies. The error is defined as the difference between the measured value and the true value as related to an acceptable national or international standard. The error in the measurement is defined as the **uncertainty which** is **indicative of the measurement accuracy.** The error in a specific measurement process can be analyzed by subdividing the uncertainties into a **fixed error (bias)** and a **random** error **(precision).** Each of the components can be evaluated for a specific process and combined yielding the overall uncertainty or error.

When a series of measurements of the same property are carried out, small differences in the various readings will result. If it is presumed that the measurement system is absolutely accurate, the differences are due to the influence of parameters beyond the control of the experimenter. When the measurement errors are truly random, they are normally distributed and the precision error can be equated to the standard deviation of the measurements. Note that the average value of the measurements is equal to the true value as related to an international standard.

In the previous paragraph, the average value was assumed to equal the true value. This is rarely -- if ever -- the case. A more typical result of repeatedly measuring the same parameter results in a random distribution about an average value but the average is now displaced from the true value by an amount equal to the bias. Note that the precision may be either positive or negative while the sign of the bias is a function of the true value-average value displacement. While the precision can be computed from a series of measurements, the bias can only be determined by comparison with a known and/or true value.

The total measurement error or uncertainty is made up of both the precision and bias errors and

$$U = \pm (b + ts)$$

where U is the uncertainty, b the bias, s the precision and t the 95th percentile point for the two-tailed Students t distribution (see Abernethy, et al [1973]). Since s is a statistical property, its value will depend on the number of measurements carried out. The value of t is 2.04 for 30 measurements and 1.96 for an infinite number. For computational simplicity, t is normally taken as 2. In general terms, the uncertainty measures data accuracy and, hence, reliability.

When the technology transfer agent provides data to a client, the data uncertainty should be provided. Most refereed journals require that all experimental data be accompanied by an uncertainty value for the measurements. If this information is not furnished in the article, the author should be contacted to ascertain the data reliability. If the agent is unable to determine the uncertainty, then this factor should be so stated in the report. Note that there is an implied data quality when the agent furnishes information to the client, i.e., the client assumes that the data is accurate. Unless otherwise stated, the agent accepts the liability associated with the data. As a consequence, it is imperative that all limitations -- including data accuracy -- be clearly spelled out.

The uncertainty measures the data accuracy and/or reliability. This is a convenient mechanism for data evaluation but it is not the only factor to be considered. The experimental methods used to derive the data will also be of value to the client. Measurement techniques have changed drastically in recent years largely due to the advent of digital and/or computer data processing methods. While the newer methods are generally more accurate, they are also subject to systematic errors on a grand scale. Since the data is processed by computer, any software errors will influence all measurements. If available, multiple data sets should be furnished. These provide a rough estimate of the uncertainty as well as a guide to the reliability of the data.

### 8.3.2. Secondary Variables

One of the most difficult problems to deal with in assessing data reliability is the impact of secondary and/or uncontrolled variables. Test programs are structured in order to control certain parameters and measure the results. For example, a wind tunnel test may be designed to measure the drag coefficients of tall buildings. The experimenter constructs a scale-model of the target and surrounding buildings, selects a series of wind velocities and measures the resulting drag coefficients. The drag coefficients are then used to design the building structure.

The primary variables are the building shape and wind velocities with the drag coefficient being the measured value.

The secondary variables can be determined by examining the actual situation. For example, the wind gusts and is not steady with time as it is in a wind tunnel. Furthermore, the actual building is a composite structure with a good deal of flexibility, not a small, rigid wooden block. The time variant property of the wind can excite resonance conditions in an actual structure. The structural flexibility in the case of a tall building can result in an unpleasant swaying much akin to being at sea in a small boat. Furthermore, the vacuum created on the down-wind side of the building may be sufficient to pull the windows out of their retaining structure. This situation actually occurred in a high-rise building in Boston with all windows disgorged under high wind conditions and deposited 60 stories below on the street. Needless to say, everything that was loose was sucked out of the upper stories along with the windows.

Consider a second case. A laboratory is testing air-to-liquid heat exchangers. The experimenters control the temperature and velocity of the air, the temperature and velocity of the liquid coolant and the heat exchanger geometry. The tests are conducted in the southwest under conditions of low ambient humidity. Following the optimization of the design, the heat exchangers are produced and eventually installed in the upper midwest. The ambient conditions in the midwest consist of low temperatures and high relative humidities. In this environment, frost forms on the units making them virtually inoperable. In this case, the uncontrolled test variable, i.e., humidity, became the primary variable under actual operating conditions.

In summary, **the technology transfer agent should define the primary and secondary test variables as well as the primary and secondary variables in the client's application.** Any difference between the two sets of variables should be duly noted. While it may be difficult to predict the impact of the secondary variables, the client should be fully informed of all test variables and the uncertainty introduced by the presence of uncontrolled variables.

### 8.3.3 Data Variability

In addition to the above factors, the technology transfer agent may also encounter data sets which are presumably generated under similar test conditions but with variable results. Figure 8.1 depicts heat transfer for flow in pipes and illustrates typical data scatter. In a case such as this, one can plot an upper and lower envelope and a mean curve and use this information to develop an uncertainty. If the variability between data sets is excessive, the agent should ascertain the similarity of the test conditions. If the test conditions are in fact similar, then the agent should forward both sets to the client. The agent should exclude data only in the event of some overriding consideration.

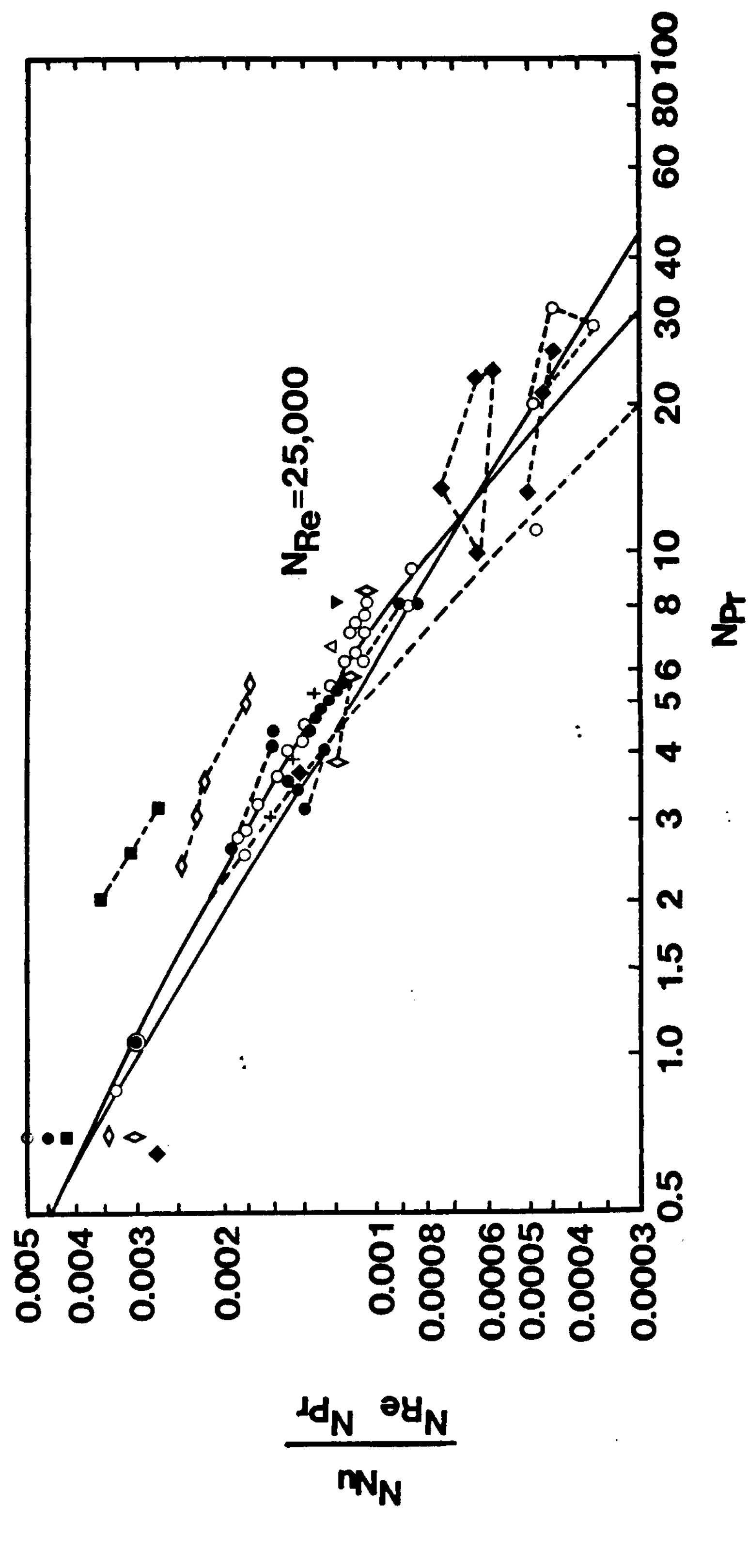


Figure 8.1 Typical Heat Transfer Data

## 8.4 Data Reformulation

### 8.4.1 Units Conversion

By far the most straight-forward data reformulation process is units conversion, i.e., English to metric or metric to English. Older publications will likely have used the English system of units while newer data will probably be presented in metric units. The client's preference should be followed in a choice of units and all data should be presented in this system.

### 8.4.2 Interpolation and Extrapolation

Interpolation is defined as estimating values of a function between two known values. Extrapolation is defined as estimating values of a variable in an unobserved interval from values within an already observed interval, i.e., the projection of known data into an unknown area. These processes are frequently encountered in demand-pull technology transfer studies since -- by definition -- technology transfer is the use of technology for a purpose other than that originally intended.

Interpolation is a frequently used data analysis process and can be employed with a high degree of confidence proven the known values are sufficiently close to the interpolated value. The process can be as simple as plotting a straight line between a graph of known values and using the line to estimate intervening values. More complex approaches employ mathematical functions with various constants determined from the measured data points. These functions are then used to estimate values at the intermediate points. A third approach employs a phenomenological model of the process with the measured data supplementing or replacing theoretically derived constants.

Interpolation can be successfully employed as long as the phenomena governing the process remains unchanged. Figure 8.2 depicts a series of measured values for flow in pipes with smooth and rough surfaces. The measurements are closely spaced and interpolation can be used with a high degree of confidence.

Consider now the following case (see Figure 8.3). Assume that data for $0.2 \leq \log (r)/ \leq 0.6$ is available from one reference and data for $2.0 < \log (r)/ \leq 3.2$ is available from a second source. Interpolation within the known data ranges would be reliable; however, interpolation in the region $0.6 \leq \log (r)/ \leq 2.0$ would entail considerable risk. This is due to both the large interval between data sets as well as the obvious change in phenomena, i.e., the data varies linearly in one region and is constant in the other.

In summary, interpolation can be very accurate when the data trends are consistent, but should be approached with caution if the two data sets demonstrate strikingly different trends.

Extrapolation should be approached with more caution than interpolation. Since extrapolation involves extending data beyond the measured field rather than inserting between known values, only one side of the field is known. As a consequence, extrapolation is subject to far greater potential errors than interpolation. Extrapolation procedures are similar to those used for interpolation: graphical, mathematical and/or phenomenological. While any one of the three is acceptable for interpolation, the phenomenological approach is preferred for extrapolation.

The success of extrapolating is limited to the constancy of the phenomena involved over the extrapolation range, i.e., as long as the physcial processes remain unchanged, the data extrapolation will be valid. If a change in process or governing parameters occurs, an extrapolation can be wildly in error. Consider Figure 8.3. Using the data in the range of $0.2 \leq \log(r) \leq 0.6$ to predict values of $\log(r) = 2$ would produce B values ca of 11 while the actual value is ca 8.5, i.e., an error of 30%. On the other hand, using the value of B at $\log(r) = 3.0$ to predict the value at $\log(r) = 4$ would be very accurate.

The variability of the data itself is also a good indicator of the reliability of the extrapolation. In Figure 8.2, extrapolating to higher Reynolds numbers for a fixed $r_o/e$ will entail little error since the f values are virtually constant. Extrapolating to lower $r_o/e$ values is subject to more uncertainty since these values are varying at an increasing rate.

In summary, extrapolation can be reliably employed when the phenomena governing the process is known and when data variability is well behaved. Even under these conditions, the uncertainty for extrapolated data should be perhaps twice that of the measured values. Extrapolating data requires sound engineering judgment and should be approached with caution.

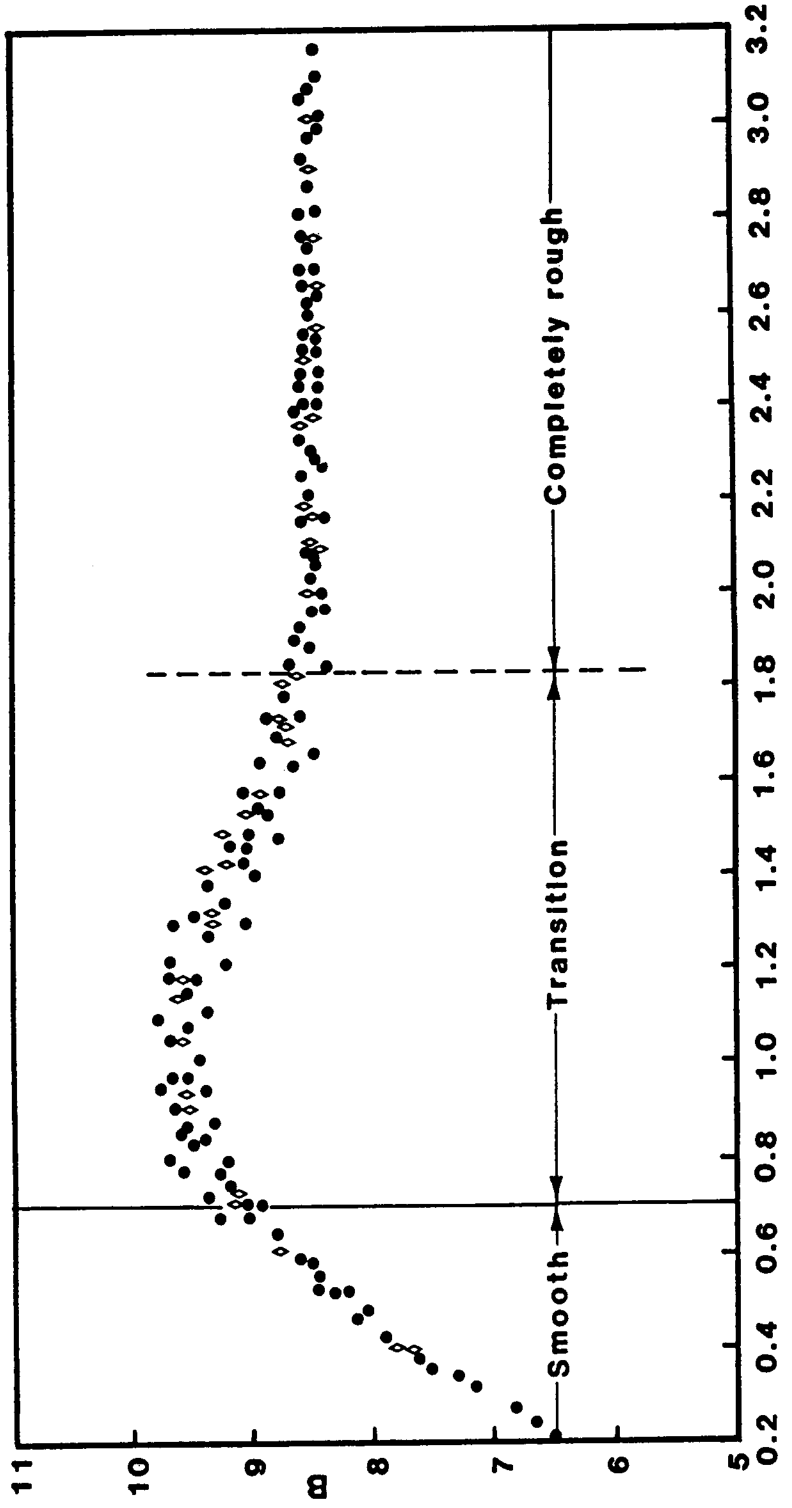


Figure 8.2 Roughness Parameter for Flows in Smooth and Rough Pipes

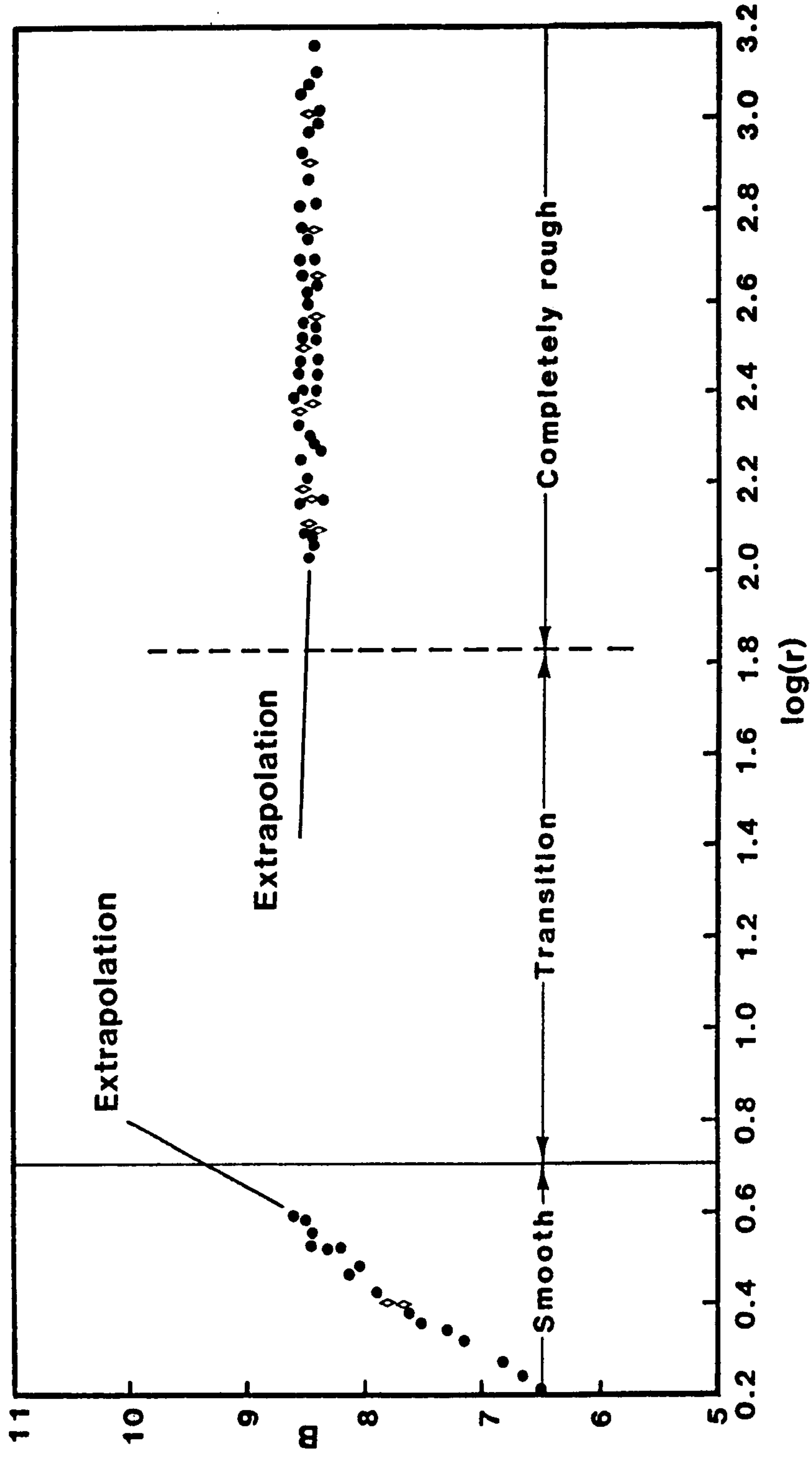


Figure 8.3 Roughness Parameter for Flows in Smooth and Rough Pipes

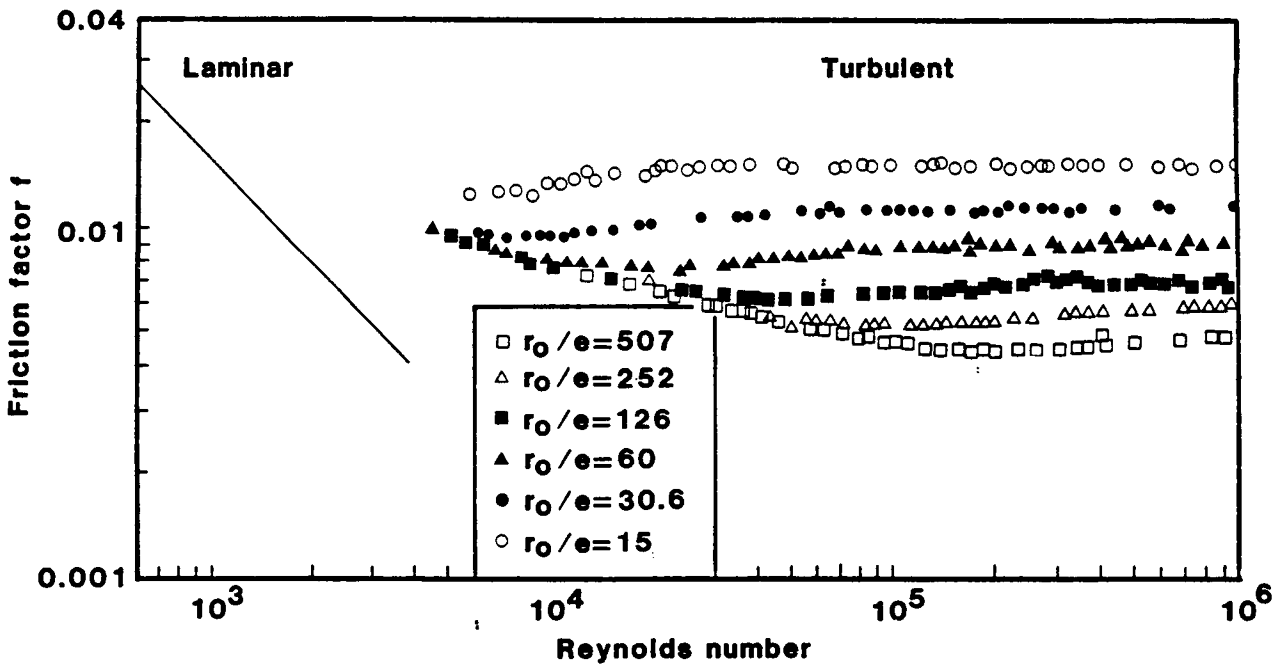


Figure 8.4 Friction Factors for Artificially Roughened Tubes

### 8.4.3 Extension of Data to Similar Conditions

Test data may have been judged relevant to the problem statement but was acquired under different test conditions, used different materials or was subject to a different test environment. In many cases the data may be reformulated to a form directly relevant to the problem statement.

Consider the following case. A client is considering designing a high-temperature, light-weight heat exchanger which will employ the liquid metal potassium as the working fluid. A bibliographic database search has failed to produce any data on potassium, but data has been located for liquid sodium. Since both sodium and potassium have similar physical characteristics, the sodium data could be used in a preliminary design study provided it is reformulated in the proper dimensionless parameters. Moving beyond the preliminary design-stage would require actual test data for potassium.

An understanding of the basic phenomena in a particular problem is extremely important. Consider the following example. A client has requested data on all adhesives having specified bonding characteristics with the application being bonding an elastomere to steel. An adhesive meeting the client's specification is located; however, all data is related to the bonding of fiborous materials. While this may appear to be relevant, it could be grossly misleading if the bonding characteristics of the adhesive are strongly dependent on the surface characteristics of the materials to be bonded.

Needless to say, one could continue indefinitely with examples. Each case must be examined individually and the agent must have a basic understanding of the physical processes governing the particular problem. There is no substitute for experience.

## 8.5 Data Presentation Formats

The reformulated data can be presented in a number of different formats such as charts, graphs, tables, equations, etc. Of these forms, graphs provide the maximum visual impact because trends are clearly obvious; tables provide the most utility. Graphs are particularly useful for explaining extrapolations. In some cases, equations should be stated. This is important if mathematical models have been used to extend or reformulate the data.

As noted in previous sections, all data limitations including measurement uncertainty should be clearly stated. All processes employed in data reformatting -- including all assumptions -- should likewise be spelled out. It is also useful to review the original data and data sources. This framework will provide enough information for the client to conduct an independent appraisal of the study.

## 8.6 Summary

Reformulation of data to a form which is useable by the recipient is a key element in the technology transfer process. This aspect of technology transfer is extremely problem specific.

As a result, only general guidelines have been presented. Even in this case, sound engineering/scientific judgment is required -- judgment that must be developed by experience.

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## MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM (1)

### NORTHEAST REGION

| Agency | Location | Contact Person |
|---|---|---|
| **Department of Agriculture** | | |
| *Forest Service* | | |
| Forest Environment Project | Pennington, NJ | Harold G. Marx |
| Forest Environment Research Unit | Amherst, MA | Harold G. Marx |
| Forest Insect & Disease Lab. | Hamden, CT | Harold G. Marx |
| Forest Science Laboratory | Durham, NH | Harold G. Marx |
| Forest Science Laboratory | Syracuse, NY | Harold G. Marx |
| Sugar Maple Laboratory | Burlington, VT | Harold G. Marx |
| Timber Research Laboratory | Orono, ME | Harold G. Marx |
| *Agricultural Research Service* | | |
| Plum Island Animal Disease Ctr. | Greenport, LI, NY | James Hall |
| **Department of Commerce** | | |
| *National Oceanic and Atmospheric Administration* | | |
| Geophysical Fluid Dynamics Lab, ERL* | Princeton, NJ | Edward V. Tiernan |
| Gloucester Lab, NMFS# | Gloucester, MA | Edward V. Tiernan |
| Milford Lab, NMFS | Milford, CT | Edward V. Tiernan |
| Narragansett Lab, NMFS | Narragansett, RI | Edward V. Tiernan |
| Northeast Fisheries Center and Woods Hole Lab, NMFS | Woods Hole, MA | Edward V. Tiernan |
| Sandy Hook Lab, NMFS | Sandy Hook, NJ | Edward V. Tiernan |
| **Department of Defense** | | |
| *Air Force* | | |
| Air Force Geophysics Lab. | Hanscom, MA | A. T. Stair, Jr. |
| Rome Air Development Center | Griffis AFB, NY | David Pierce |

*ERL - Environmental Research Laboratories, Office of Oceanic and Atmospheric Research
#NMFS - National Marine Fisheries Service

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(1) Extracted from McNamara, M. M. [1986], "Report to the Federal Agencies on the Activities of the Federal Laboratory Consortium (FLC)", Federal Laboratories Consortium for Technology Transfer.

## MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

### NORTHEAST REGION

| Agency | Location | Contact Person |
| --- | --- | --- |
| <u>Army</u> | | |
| Army Aeromechanical Engineering Laboratory | Natick, MA | Joel Carlson |
| Army Avionics R&D Activity | Fort Monmouth, NJ | Roy Warhover |
| Army Cold Regions Research & Engineering Laboratory | Hanover, NH | Andrew Assur |
| Army Food Engineering Lab. | Natick, MA | Joel Carlson |
| Army Individual Protection Laboratory | Natick, MA | Joel Carlson |
| Army Large Caliber Weapons Systems Laboratory | Dover, NJ | Paul L. Marinkas |
| Army Materials & Mechanics Research Center | Watertown, MA | David W. Seitz |
| Army Research Institute of Environmental Medicine | Natick, MA | Brandon E. Joyce |
| Army Armament R&D Center | Dover, NJ | Ray Weir |
| Army Fire Control & Small Weapons System Lab. | Dover, NJ | Henry Opat |
| Army Communication-Electronics Command | Ft. Monmouth, NJ | John Boyle |
| Army Combat Surveillance & Target Acquisition Lab. | Ft. Monmouth, NJ | C. J. Chatlynne |
| Army Electronics Technology & Devices Lab. | Ft. Monmouth, NJ | C. J. Chatlynne |
| <u>Navy</u> | | |
| Naval Air Engineering Center | Lakehurst, NJ | Ray Rhode |
| Naval Underwater Systems Center New London Laboratory | New London, CT | Margaret M. McNam |
| Naval Underwater Systems Center Newport Laboratory | Newport, RI | Margaret M. McNama |
| <u>Department of Energy</u> | | |
| Bates Linear Accelerator Ctr. | Millerton, MA | William Lobar |
| Brookhaven National Laboratory | Upton, NY | William Marcuse |
| Environmental Measurements Lab. | New York, NY | Herbert L. Volcho |
| Princeton Plasma Physics Lab. | Princeton, NJ | Ellis Simon |

# MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

## NORTHEAST REGION

| Agency | Location | Contact Person |
|---|---|---|
| **Department of Interior** | | |
| *Fish and Wildlife Service* | | |
| National Fishery Research & Development Lab. | Wellsboro, PA | Duncan MacDonald |
| Tunison Laboratory of Fish Nutrition | Cortland, NY | Duncan MacDonald |
| **Department of Transportation** | | |
| Coast Guard R&D Center | Groton, CT | Michael D'Angelo |
| Transportation Systems Center | Cambridge, MA | R. V. Giangrande |
| Federal Aviation Administration Technical Center | Altantic City, NJ | C. Keith Law |
| **Environmental Protection Agency** | | |
| Environmental Research Lab. | Narrangansett, RI | Michael Mastracci |
| Oils & Hazardous Materials Spills Branch | Edison, NJ | Michael Mastracci |

## MID-ATLANTIC REGION

| | | |
|---|---|---|
| **Department of Agriculture** | | |
| *Forest Service* | | |
| Forest Products & Marketing Lab. | Princetown, WV | Harold G. Marx |
| Forestry Sciences Laboratory | Blacksburg, VA | Harold G. Marx |
| Forestry Sciences Laboratory | Morgantown, WV | Harold G. Marx |
| Forestry Sciences Laboratory | Warren, PA | Harold G. Marx |
| Northeastern Forest & Range Experiment Station | Upper Darby, PA | Harold G. Marx |
| Physiology Laboratory | Beltsville, MD | Harold G. Marx |
| Timber & Watershed Laboratory | Parsons, WV | Harold G. Marx |
| *Agricultural Research Service* | | |
| Beltsville Agricultural Research Center | Beltsville, MD | James Hall |
| Human Nutrition Research Center | Beltsville, MD | James Hall |
| National Arboretum | Washington, DC | James Hall |
| Eastern Regional Research Ctr. | Wyndmoor, PA | A. M. Cowan |

# MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

## MID-ATLANTIC REGION

| Agency | Location | Contact Person |
|---|---|---|
| Extension Service | Washington, DC | Theodore T. Maher |
| **Department of Commerce** | | |
| National Bureau of Standards | Washington, DC | James Wyckoff |
| National Oceanic and Atmospheric Administration | | |
| Advanced Systems Lab, NWS# | Silver Spring, MD | Edward V. Tiernan |
| Air Resources Lab, NWS | Rockville, MD | Edward V. Tiernan |
| Assessment and Information Services Center, NESDIS* | Washington, DC | Edward V. Tiernan |
| Climate Analysis Center, NWS | Camp Springs, MD | Edward V. Tiernan |
| Climate and Earth Sciences Lab, NESDIS | Suitland, MD | Edward V. Tiernan |
| Hydrologic Research Lab, NWS | Silver Spring, MD | Edward V. Tiernan |
| Integrated Systems Lab, NWS | Silver Spring, MD | Edward V. Tiernan |
| National Oceanographic Data Center, NESDIS | Washington, DC | Edward V. Tiernan |
| National Systematics Lab, NMFS | Washington, DC | Edward V. Tiernan |
| Oxford Lab, NMFS | Oxford, MD | Edward V. Tiernan |
| Satellite Applications Lab, NESDIS | Camp Springs, MD | Edward V. Tiernan |
| Satellite Experiment Lab, NESDIS | Suitland, MD | Edward V. Tiernan |
| Techniques Development Lab, NWS | Silver Spring, MD | Edward V. Tiernan |
| **Department of Defense** | | |
| Air Force | | |
| Air Force Systems Command Laboratories | Andrews AFB, DC | Walter R. Blados |
| Army | | |
| Army Applied Technology Lab. | Fort Eustis, VA | Roy J. Warhover |
| Army Ballistic Research Lab. | Aberdeen, MD | Arthur D. Coates |
| Army Engineer Topographic Laboratories | Fort Belvoir, VA | Richard N. Foreman |
| Army Human Engineering Lab | Aberdeen, MD | Donald O. Egner |

#NWS - National Weather Service
*NESDIS - National Environmental Satellite, Data, and Information Service

## MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

### MID-ATLANTIC REGION

| Agency | Location | Contact Person |
|---|---|---|
| **Army (continued)** | | |
| Army Institute of Dental Research | Washington, DC | Gino C. Battistone |
| Army Medical Bioengineering Research | Frederick, MD | Robert J. Summary |
| Army Medical Research Institute of Infectious Diseases | Frederick, MD | Wm. C. Patrick, III |
| Army Belvoir R&D Center | Fort Belvoir, VA | M. Connie Harrisson |
| Army Night Vision & Electro-Optics Laboratories | Fort Belvoir, VA | Marguerite McFarland |
| Army Material Command | Alexandria, VA | E. J. (Jack) Kolb |
| Army Electronics R&D Command | Adelphi, MD | C. J. Chatlynne |
| Army Chemical R&D Center | Aberdeen Proving Ground, MD | R. Hinkle |
| Army Research Institute for Behavioral & Social Sciences | Alexandria, VA | Edward Fuentes |
| Army Structures Laboratory | Hampton, VA | Roy J. Warhover |
| Chemical Research & Development Center | Aberdeen, MD | Ronald Hinkle |
| Coastal Engineering Research Center | Fort Belvoir, VA | Dennis Berg |
| Harry Diamond Laboratory | Adelpha, MD | Clifford E. Lanham |
| Medical Research Institute of Chemical Defense | Aberdeen, MD | Susan Luckan |
| Walter Reed Army Institute of Research | Washington, DC | B. Nolan Dale |
| Army Signals Warfare Lab. | Warrenton, VA | Royal H. Burkhardt |
| **Navy** | | |
| David W. Taylor Naval Ship R&D Center | Bethesda, MD | Basil Nakonechny |
| Naval Air Development Center | Warminster, PA | Jerome Bortman |
| Naval Explosive Ordnance Disposal Center | Indian Head, MD | Lionel Dickinson |
| Naval Research Laboratory | Washington, DC | Richard Fulper, Jr. |
| Naval Surface Weapons Center | White Oak, MD | Ramsey Johnson |
| **Department of Energy** | | |
| Morgantown Energy Tech. Ctr. | Morgantown, WV | Claire H. Sink |
| Pittsburg Energy Tech. Ctr. | Pittsburg, PA | William C. Peters |

# MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

## MID-ATLANTIC REGION

| Agency | Location | Contact Person |
| --- | --- | --- |
| **Department of Health & Human Services** | | |
| Medical Devices Laboratory | Rockville, MD | Edward Mueller |
| **Department of Interior** | | |
| Bureau of Mines | | |
| USBM Technology Transfer Group | Washington, DC | Donald E. Ralston |
| Avondale Research Center | Avondale, MD | Donald E. Ralston |
| Pittsburg Research Center | Pittsburg, PA | Donald E. Ralson |
| Fish & Wildlife Service | | |
| Eastern Energy and Land Use Team | Kearneysville, WV | Duncan MacDonald |
| National Fisheries Center - Leetown | Kearneysville, WV | Duncan MacDonald |
| Patuxent Wildlife Research Ctr. | Laurel, MD | Duncan MacDonald |
| Geological Survey | | |
| USGS National Center | Reston, VA | Ethan T. Smith |
| **Department of Justice** | | |
| Federal Bureau of Investigation | Quantico, VA | Kenneth W. Nimmick |
| **Department of Transportation** | | |
| Fairbank Highway Research Station | Washington, DC | Robert Betsold |
| **Environmental Protection Agency** | | |
| Vint Hill Field Station | Warrington, VA | Michael Mastracci |
| **National Aeronautics & Space Administration (NASA)** | | |
| Goddard Space Flight Center | Greenbelt, MD | Donald S. Friedman |
| Langley Research Center | Hampton, VA | John Samos |
| Wallops Flight Center | Wallops, VA | Gilmore H. Traffor |

## MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

### SOUTHEAST REGION

| Agency | Location | Contact Person |
|---|---|---|
| **Department of Agriculture** | | |
| *Forest Service* | | |
| Coweeta Hydrologic Laboratory | Franklin, NC | Harold G. Marx |
| Forest Fire Laboratory | Macon, GA | Harold G. Marx |
| Forest Hydrology Laboratory | Oxford, MS | Harold G. Marx |
| Forest Recreation Unit | Tuskegee, AL | Harold G. Marx |
| Forest Resources Laboratory | Lehigh Acres, FL | Harold G. Marx |
| Forest Tree Seed Laboratory | State College, MS | Harold G. Marx |
| Forestry Recreation Unit | Clemson, SC | Harold G. Marx |
| Forestry Sciences Laboratory | Athens, GA | Harold G. Marx |
| Forestry Sciences Laboratory | Auburn, AL | Harold G. Marx |
| Forestry Sciences Laboratory | Berea, KY | Harold G. Marx |
| Forestry Sciences Laboratory | Charleston, SD | Harold G. Marx |
| Forestry Sciences Laboratory | Marianna, FL | Harold G. Marx |
| Forestry Sciences Laboratory | Research Triangle, NC | Harold G. Marx |
| Institute of Forest Genetics & Forest Insect & Disease Laboratory | Gulfport, MS | Harold G. Marx |
| Institute of Tropical Forestry | Pio Pedras, Puerto Rico | Harold G. Marx |
| Naval Stores & Timber Product Laboratory | Olustee, FL | Harold G. Marx |
| Silviculture Laboratory | Sewanee, TN | Harold G. Marx |
| Southeast Forest Experiment Station | Ashville, NC | Gordon Lewis |
| Southern Hardwoods Laboratory | Stoneville, MS | Harold G. Marx |
| *Agricultural Research Service* | | |
| Delta States Research Center | Stoneville, MS | James Hall |
| Richard B. Russell Research Ctr. | Athens, GA | James Hall |
| **Department of Commerce** | | |
| *National Oceanic and Atmospheric Administration* | | |
| Atlantic Oceanographic and Meteorological Labs, ERL | Miami, FL | Edward V. Tiernan |
| Beaufort Lab, NMFS | Beaufort, NC | Edward V. Tiernan |
| Charleston Lab, NMFS | Charleston, SC | Edward V. Tiernan |
| Mississippi Lab, NMFS | NSTL Station, MS | Edward V. Tiernan |
| National Climatic Data Center, NESDIS | Asheville, NC | Edward V. Tiernan |
| NOAA Data Buoy Center, NWS | NSTL Station, MS | Edward V. Tiernan |

## MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

### SOUTHEAST REGION

| Agency | Location | Contact Person |
|---|---|---|
| **National Oceanic and Atmospheric Administration** (continued) | | |
| Panama City Lab, NMFS | Panama City, FL | Edward V. Tiernan |
| Southeast Fisheries Center and Miami Lab, NMFS | Miami, FL | Edward V. Tiernan |
| **Department of Defense** | | |
| *Air Force* | | |
| Air Force Armament Laboratory | Eglin AFB, FL | Albert Young |
| Air Force Engineering & Services Center | Tyndall AFB, FL | Bob Van Orman |
| *Army* | | |
| Army Aeromedical Research Lab. | Fort Rucker, AL | Sybil H. Bullock |
| Army Engineers Waterways Experiment Station | Vicksburg, MS | Joseph V. Dawsey |
| Army Missile R&D Command | Redstone Arsenal, AL | Howard C. Race |
| Army Research Office | Research Triangle Park, NC | Rodney I. McCormick |
| *Navy* | | |
| Naval Coastal Systems Lab. | Panama City, FL | Don Wright |
| Naval Oceanographic Office | Bay St. Louis, MS | Clay Griffith |
| Naval Ocean R&D Activity | NSTL, MS | George Stanford, J |
| **Department of Energy** | | |
| Center for Energy & Environment Research | San Juan, Puerto Rico | Angel Calderon |
| Oak Ridge Associated Universities | Oak Ridge, TN | Tina McKinley |
| Oak Ridge National Laboratory | Oak Ridge, TN | Donald Jared |
| Y-12 Plant | Oak Ridge, TN | Donald Jared |
| Oak Ridge Gaseous Diffusion Plant | Oak Ridge, TN | Donald Jared |
| Paducah Gaseous Diffusion Plant | Paducah, KY | Donald Jared |
| DOE Technical Information Center | Oak Ridge, TN | Wm. F. Simpson, J |
| Savannah River Ecology Lab. | Aiken, SC | Michael H. Smith |
| Savannah River Laboratory | Aiken, SC | C. Banick |

# MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

## SOUTHEAST REGION

| Agency | Location | Contact Person |
|---|---|---|
| **Department of Health and Human Services** | | |
| **National Institutes of Health** | | |
| Center for Disease Control | Atlanta, GA | Joyce Essien |
| **Department of Interior** | | |
| **Bureau of Mines** | | |
| Tuscaloosa Research Center | Tuscaloosa, AL | Donald E. Ralston |
| **Fish & Wildlife Service** | | |
| National Coastal Ecosystems Team | Slidell, LA | Duncan MacDonald |
| National Fishery Research Lab - Gainsville | Gainsville, FL | Duncan MacDonald |
| Southeastern Fish Cultural Lab. | Marion, AL | Duncan MacDonald |
| **Environmental Protection Agency** | | |
| Environmental Criteria and Assessment Office | Research Triangle Park, NC | Si Duk Lee |
| Environmental Monitoring Systems Laboratory | Research Triangle Park, NC | Si Duk Lee |
| Environmental Research Lab | Athens, GA | Michael Mastracci |
| Environmental Research Lab | Gulf Breeze, FL | Michael Mastracci |
| Environmental Sciences Research Laboratory | Research Triangle Park, NC | Si Duk Lee |
| Health Effects Research Lab | Research Triangle Park, NC | Si Duk Lee |
| Industrial Environmental Research Laboratory | Research Triangle Park, NC | Si Duk Lee |
| **National Aeronautics & Space Administration (NASA)** | | |
| George Marshall Space Flight Center | Marshall SFC, AL | Ismail Akbay |
| Kennedy Space Center | Kennedy SC, FL | Reed Barnett |
| National Space Technology Laboratories | Bay St. Louis, MS | Robert M. Barlow |

# MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

## MID-WEST REGION

| Agency | Location | Contact Person |
|---|---|---|
| **Department of Agriculture** | | |
| *Forest Service* | | |
| Forest Engineering Laboratory | Houghton, MI | Harold G. Marx |
| Forest Inset & Disease Lab. | Delaware, OH | Harold G. Marx |
| Forest Products Laboratory | Madison, WI | Rod G. Larson |
| Forestry Sciences Laboratory | Carbondale, IL | Harold G. Marx |
| Institute of Forest Genetics | Rhinelander, WI | Harold G. Marx |
| North Central Forest Experiment Station | St. Paul, MN | Harold G. Marx |
| Northern Conifers Laboratory | Grand Rapids, MN | Harold G. Marx |
| Northern Hardwoods Laboratory | LaCrosse, WI | Harold G. Marx |
| *Agricultural Research Service* | | |
| Northern Regional Research Ctr. | Peoria, ILL | A. M. Cowan |
| **Department of Commerce** | | |
| *National Oceanic and Atmospheric Administration* | | |
| Great Lakes Environmental Research Lab, ERL | Ann Arbor, MI | Edward V. Tiernan |
| Satellite Development Lab, NESDIS | Madison, WI | Edward V. Tiernan |
| **Department of Defense** | | |
| *Air Force* | | |
| Air Force Aeropropulsion Lab. | Wright Patterson, OH | Cindy Ingalls |
| Air Force Aerospace Medical Research Laboratory | Wright Patterson, OH | Cindy Ingalls |
| Air Force Avionics Laboratory | Wright Patterson, OH | Cindy Ingalls |
| Air Force Materials Laboratory | Wright Patterson, OH | Cindy Ingalls |
| Air Force Wright Aeronautical Laboratory | Wright Patterson, OH | Cindy Ingalls |
| *Army* | | |
| Army Construction Engineering Research Laboratory | Champaign, IL | G. R. Williamson |
| Army Propulsion Laboratory | Cleveland, OH | Roy J. Warhover |
| Army Tank-Automotive R&D Command | Warren, MI | Robert Hostetler |

## MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

### MID-WEST REGION

| Agency | Location | Contact Person |
|---|---|---|
| <u>Navy</u> | | |
| Naval Weapons Support Center | Crane, IN | Terry Weaver |
| <u>Department of Energy</u> | | |
| Argonne National Laboratory | Argonne, IL | Dick Ivins |
| Fermi National Accelerator Laboratory | Batavia, IL | R. A. Carrigan, Jr. |
| New Brunswick Laboratory | Argonne, IL | Carleton D. Bingham |
| MSU/DOE Plant Research Lab. | East Lansing, MI | Gary W. Watson |
| Notre Dame Radiation Lab. | Notre Dame, IN | John Bentley |
| <u>Department of Interior</u> | | |
| <u>Bureau of Mines</u> | | |
| Twin Cities Research Center | Minneapolis, MN | Donald E. Ralston |
| <u>Fish & Wildlife Service</u> | | |
| National Fishery Research Lab - LaCrosse | LaCrosse, WI | Duncan MacDonald |
| Great Lakes Fishery Laboratory | Ann Arbor, MI | Duncan MacDonald |
| National Fish & Wildlife Health Laboratory | Madison, WI | Duncan MacDonald |
| <u>Department of Health and Human Services</u> | | |
| National Institute for Occupational Safety & Health | Cincinnati, OH | T. F. Schoenborn |
| <u>Environmental Protection Agency</u> | | |
| Environmental Criteria and Assessment Office | Cincinnati, OH | Michael Mastracci |
| Environmental Monitoring Systems Laboratory | Cincinnati, OH | Michael Mastracci |
| Industrial Environmental Research Laboratory | Cincinnati, OH | Michael Mastracci |
| Environmental Research Lab | Duluth, MN | Michael Mastracci |
| Grosse Ile Field Station | Grosse Ile, MI | Michael Mastracci |
| Monticello Field Station | Monticello, MN | Michael Mastracci |
| Municipal Environmental Research Laboratory | Cincinnati, OH | Michael Mastracci |
| Newton Field Station | Newton, OH | Michael Mastracci |

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MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

MID-CONTINENT REGION

| Agency | Location | Contact Person |
|---|---|---|
| **National Aeronautics & Space Administration (NASA)** | | |
| Lewis Research Center | Cleveland, OH | Harrison Allen, Jr |
| **Department of Agriculture** | | |
| Forest Service | | |
| Alexandria Forestry Center | Alexandria, LA | Harold G. Marx |
| Forest Range & Watershed Lab. | Laramie, WY | Harold G. Marx |
| Forest Research Laboratory | Rapid City, SD | Harold G. Marx |
| Forestry Sciences Laboratory | Albuquerque, NM | Harold G. Marx |
| Forestry Sciences Laboratory | Bozeman, MT | Harold G. Marx |
| Forestry Sciences Laboratory | Fayetteville, AR | Harold G. Marx |
| Forestry Sciences Laboratory | Logan, UT | Harold G. Marx |
| Forestry Sciences Laboratory | Missoula, MT | Harold G. Marx |
| Intermountain Forest Range Experiment Station | Ogden, UT | Harold G. Marx |
| Northern Forest Fire Lab. | Missoula, MT | Harold G. Marx |
| Rocky Mountain, Forest & Range Experiment Station | Fort Collins, CO | Harold G. Marx |
| Shelterbelt Laboratory | Bottineau, ND | Harold G. Marx |
| Shelterbelt Laboratory | Lincoln, NE | Harold G. Marx |
| Shrub Improvement Laboratory | Provo, UT | Harold G. Marx |
| Southern Forest Experiment Station | New Orleans, LA | Harold G. Marx |
| Wildlife Habitat & Silviculture Laboratory | Nacogdoches, TX | Harold G. Marx |
| Equipment Development Center | Missoula, MT | Farnum M. Burbank |
| Agricultural Research Service | | |
| National Animal Disease Center | Ames, IA | James Hall |
| US Grain Marketing Laboratory | Manhattan, KS | James Hall |
| Metabolism and Radiation Lab. | Fargo, ND | James Hall |
| Southern Regional Research Ctr. | New Orleans, LA | A. M. Cowan |
| **Department of Commerce** | | |
| National Oceanic and Atmospheric Administration | | |
| Aeronomy Lab, ERL | Boulder, CO | Edward V. Tiernan |
| Galveston Lab, NMFS | Galveston, TX | Edward V. Tiernan |
| National Geophysical Data Center, NESDIS | Boulder, CO | Edward V. Tiernan |
| National Severe Storms Lab, ERL | Norman, OK | Edward V. Tiernan |

## MEMBERS OF THE FEDERAL LABORATORY CONSORTIUM

### MID-CONTINENT REGION

| Agency | Location | Contact Person |
|---|---|---|
| **National Oceanic and Atmospheric Administration (continued)** | | |
| Space Environment Lab, ERL | Boulder, CO | Edward V. Tiernan |
| Wave Propagation Lab, ERL | Boulder, CO | Edward V. Tiernan |
| **National Telecommunication & Information Administration** | | |
| Institute for Telecommunication | Boulder, CO | Val M. O'Day |
| **Department of Defense** | | |
| **Air Force** | | |
| Air Force Aerospace Medical Division | Brooks AFB, TX | James S. Turner |
| Air Force Human Resources Lab. | Brooks AFB, TX | Joseph Hazel |
| Air Force School of Aerospace Medicine | Brooks AFB, TX | Walter R. Blados |
| Air Force Weapons Laboratory | Kirtland AFB, NM | Margaret Putnam |
| Frank J. Seiler Research Lab. | USAF Academy, CO | Walter R. Blados |
| **Army** | | |
| Army Institute of Surgical Research | Fort Sam Houston, TX | Basil A. Pruitt, Jr |
| Dugway Proving Grounds | Dugway, UT | Lothar L. Salomom |
| Army Atmospheric Sciences Lab. | White Sands Missle Range, NM | Carl Wright |
| Army Aviation Systems Command | St. Louis, MO | Roy J. Warhover |
| **Department of Energy** | | |
| Ames Laboratories | Ames, IA | Daniel E. Williams |
| Bartlesville Project Office | Bartlesville, OK | C. C. Linville |
| Inhalation Toxicology Research Institute | Albuquerque, NM | Robert K. Jones |
| Los Alamos Scientific Lab. | Los Alamos, NM | Eugene Stark |
| Radiobiology Laboratory (U of Utah) | Salt Lake, UT | Walter Stevens |
| Rocky Flats Plant | Golden, CO | Robert M. Nelson |
| Sandia Laboratories | Albuquerque, NM | Robert P. Stromberg |
| Solar Energy Research Institute | Golden, CO | H. Dana Moran |

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| Rolla Research Center | Rolla, MO | Donald E. Ralston |
| Salt Lake City Research Center | Salt Lake, UT | Donald E. Ralston |
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| Fish Farming Experimental Station | Stuggart, AR | Duncan MacDonald |
| National Fishery Research Lab - Columbia | Columbia, MO | Duncan MacDonald |
| Northern Prarie Wildlife Research Center | Jamestown, ND | Duncan MacDonald |
| Office of Information Transfer | Fort Collins, CO | Duncan MacDonald |
| Western Energy & Lane Use Team | Fort Collins, CO | Duncan MacDonald |
| **<u>Environmental Protection Agency</u>** | | |
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| Robert S. Kerr Environmental Research Laboratory | Ada, OK | Michael Mastracci |
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| Equipment Development Center | San Dimas, CA | Farnum M. Burbank |
| Forest Engineering Laboratory | Seattle, WA | Harold G. Marx |
| Forest Fire Laboratory | Riverside, CA | Harold G. Marx |
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| Forest Hydrology Laboratory | Wenatchee, WA | Harold G. Marx |
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| Forestry Sciences Laboratory | Flagstaff, AZ | Harold G. Marx |
| Forestry Sciences Laboratory | Juneau, AK | Harold G. Marx |
| Forestry Sciences Laboratory | Moscow, ID | Harold G. Marx |
| Forestry Sciences Laboratory | Olympia, WA | Harold G. Marx |
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| Institute of Pacific Island Forestry | Honolulu, HI | Harold G. Marx |
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| Honolulu Lab, NMFS | Honolulu, HI | Edward V. Tiernan |
| Northwest and Alaska Fisheries and Seattle Lab, NMFS | Seattle, WA | Edward V. Tiernan |
| Northwest Ocean Service Center, NOS* | Seattle, WA | Edward V. Tiernan |
| Pacific Marine Environmental Lab, ERL | Seattle, WA | Edward V. Tiernan |
| Southwest Fisheries Center and La Jolla Lab, NMFS | LaJolla, CA | Edward V. Tiernan |
| Tiburon Lab, NMFS | Tiburon, CA | Edward V. Tiernan |

*NOS - National Ocean Service

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## APPENDIX 3

## PRACTICE SET

<u>Using Bibliographic Databases in Technology Transfer</u> reviews all the steps in demand-pull technology transfer. Many of these steps involve bibliographic database searching and analysis of the resulting citations. The practice set leads you through the steps of pre-processing, database access, database use and citation analysis.

In order to replicate the practice set, you must have Smartcom II (Chapter 6), SORT-AID (Chapter 7), access to NASA RECON (Chapter 4) and an IBM-compatible microcomputer having 524 kb of main memory, a removable 360 kb disk drive, a 10 mb fixed disk drive, a programmable modem (Hayes compatible), and a printer. You should be familiar with the operation of a microcomputer -- know how to install software programs, format disks, etc. If you are unfamiliar with these topics, consult your MS-DOS, Smartcom II and SORT-AID user's manuals.

The practice set uses Smartcom II and SORT-AID in sequence. Smartcom II is used to control the modem, access the NASA RECON database and save the search strategy and citations on disk file. SORT-AID is used to analyze the citations. You must be able to install Smartcom II and SORT-AID. While this is usually straight-forward, you may encounter problems. If so, consult your user's manuals. The practice set does not review any installation procedures and assumes that the two programs have been installed and are functioning properly.

The practice set consists of a series of computer screens for Smartcom II, NASA RECON and SORT-AID. The screens follow the steps described in the book. The narrative following each screen describes the function performed and the action required to produce the screen. Unless otherwise stated, each action -- keystroke or series of keystrokes -- is followed by a carriage return. For example, "enter 1" means "type the number 1 followed by a carriage return".

By working through the practice set, you will develop the skills required to acquire and analyze citations. As you now know, technology transfer is much more than citations, but without technology there is no transfer. Good luck!

```
   Smartcom II            Hayes Microcomputer Products, Inc.

1. Begin Communication  *. Receive File         7. Change Printer Status  (OFF)
2. Edit Set             *. Send File            *. Select Remote Access   (OFF)
3. Select File Command  6. Change Configuration 9. Display Disk Directory (OFF)
A,B - Change Drive                              0. End Communication/Program
                        Press F2 For Help
Enter Selection: 1      Press F1 To Return On-Line

                  Dials or answers phone with Smartmodem









   2:36 pm                 Tuesday March 10, 1987                   CAPS
```

Screen 1. Smartcom II Master Menu.

This menu appears following the installation of Smartcom II. The functions that will be employed in the practice set are Begin Communication (1), Edit Set (2), and Select File Command (3).

---

Keystroke(s)

1. Enter a 2 (no carriage return)
   (selects the edit set option)

2. Enter an S (no carriage return)
   (selects the set option)

---

Screen 2 now appears.

```
Smartcom II               Hayes Microcomputer Products, Inc.

1. Begin Communication  *. Receive File          7. Change Printer Status  (OFF)
2. Edit Set             *. Send File             *. Select Remote Access   (OFF)
3. Select File Command  6. Change Configuration  9. Display Disk Directory (OFF)
A,B - Change Drive                               0. End Communication/Program
                        Press F2 For Help
Enter Selection: 2      P(arameters, M(acros, R(eports, C(opy, S(et, B(atch: S
Enter Label: Z

Communication Directory:

 A - CompuServe Direct       J - OAG EE Telenet          S - CompuServe Datapac
 B - CompuServe Telenet      K - OAG EE Tymnet           T - DJN/R Datapac
 C - CompuServe Tymnet       L - OAG EE UNINET           U - KNOWLEDGE INDEX Data
 D - DJN/R Telenet           M - THE SOURCE Direct       V - OAG EE Datapac
 E - DJN/R Tymnet            N - THE SOURCE Telenet      W - THE SOURCE Datapac
 F - DJN/R UNINET            O - THE SOURCE UNINET       X - NASA RECON
 G - KNOWLEDGE INDEX Tel     P - Honeywell               Y - DEC VAX 11/780
 H - KNOWLEDGE INDEX Tym     Q - Lawrence Laboratory1    Z - Standard Values
 I - MCI Mail                R - Lawrence Laboratory2


  10:29 pm                Tuesday March 10, 1987                     CAPS
```

Screen 2. Smartcom II Master Menu with Communication Directory.

You must now select a set for use with NASA RECON.

---

Keystroke(s)

1. Enter an X (no carriage return)
   (selects set X)

2. Enter a P (no carriage return)
   (selects parameters)

---

Screen 3 now appears.

PARAMETERS

Name of Set: X - NASA RECON          Press F2 For Help

```
          TRANSMISSION PARAMETERS                    KEYBOARD DEFINITIONS
                    Duplex:  HALF                     Escape Key: 128 (F1)
                      Baud:  300                        Help Key: 129 (F2)
      Character Processing:  FORMATTED               Printer Key: 130 (F3)
        Show Control Codes:  NO                      Capture Key: 131 (F4)
                Page Pause:  YES                Macro Prefix Key: 132 (F5)
         Show Status Lines:  YES                       Break Key: 133 (F6)
              Confidential:  NO                     Break Length:  35 (0.01 sec.)
       Include Line Feeds:  NO                      Protect Key: 134 (F7)
           Character Delay:    0 (0.001 sec.)
                Line Delay:    0 (0.01 sec.)          PROTOCOL PARAMETERS
          Character Format:  8 DATA + NONE + 1 STOP  Receive Time-out:  60 (sec.)
                  Emulator:  TTY                        Send Time-out:  10 (sec.)
                                               Error-Free Protocol: HAYES
        TELEPHONE PARAMETERS                 Stop/Start- Stop Char:  19 (DC3)
  Answer On Ring:    1                                   Start Char:  17 (DC1)
   Remote Access:  NONE    Password:           Send Lines- EOL Char:  10 (LF )
    Phone Number: 8,       ,3016210350                  Prompt Char:  32 (" ")


     2:39 pm                  Tuesday March 10, 1987                    CAPS
```

Screen 3. Smartcom II Menu for Set X.

---

Keystroke(s)

1. Enter the name NASA RECON

2. Enter the baud rate
   (300 is slower but will produce noise-free results)

3. Enter the page pause
   ("yes" will halt between each page when you are online)

4. Enter phone number

   [Record to Disk] prompt appears on the screen

5. Enter Y

---

All entries aside from the name and phone-number are predetermined and can be cycled between values using the left and right arrow keys -- ← → . For example, baud values are 110, 300 and 1200. Each entry can be accessed using the up and down arrow keys -- ↑ ↓ . The phone number can consist of the NASA RECON number as well as access numbers. In this example, WATS access begins with 8 followed by a 6 digit user code -- purposely deleted in the example -- and the NASA RECON number. Commas provide a pause in the dialing process.

Screen 4 now appears.

```
Smartcom II              Hayes Microcomputer Products, Inc.

1. Begin Communication  *. Receive File          7. Change Printer Status  (OFF)
2. Edit Set             *. Send File             *. Select Remote Access   (OFF)
3. Select File Command  6. Change Configuration  9. Display Disk Directory (OFF)
A,B - Change Drive                               0. End Communication/Program
                        Press F2 For Help
Enter Selection: 1      O(riginate, A(nswer, D(ata: O
Enter Label: X

Communication Directory:

 A - CompuServe Direct     J - OAG EE Telenet         S - CompuServe Datapac
 B - CompuServe Telenet    K - OAG EE Tymnet          T - DJN/R Datapac
 C - CompuServe Tymnet     L - OAG EE UNINET          U - KNOWLEDGE INDEX Data
 D - DJN/R Telenet         M - THE SOURCE Direct      V - OAG EE Datapac
 E - DJN/R Tymnet          N - THE SOURCE Telenet     W - THE SOURCE Datapac
 F - DJN/R UNINET          O - THE SOURCE UNINET      X - NASA RECON
 G - KNOWLEDGE INDEX Tel   P - Honeywell              Y - DEC VAX 11/780
 H - KNOWLEDGE INDEX Tym   Q - Lawrence Laboratory1   Z - Standard Values
 I - MCI Mail              R - Lawrence Laboratory2


   2:44 pm                 Tuesday March 10, 1987                     CAPS
```

Screen 4. Smartcom II Master Menu with Communications Directory.

You have now returned to the Master Menu with set X configured for NASA RECON. You will use Smartcom II to save both your search and citation files. It is best to use your removable drive for this, so

---

Keystroke(s)

1. Enter an A (no carriage return)
   (this will direct files to drive A)

2. Enter 1 (no carriage return)
   (selects Begin Communication)

3. Enter O (no carriage return)
   (selects Originate -- Smartcom II will originate call)

4. Enter X (no carriage return)
   (selects set X -- NASA RECON)

---

Screen 5 now appears.

```
Smartcom II              Hayes Microcomputer Products, Inc.

1. Begin Communication   *. Receive File          7. Change Printer Status  (OFF)
2. Edit Set              *. Send File             *. Select Remote Access   (OFF)
3. Select File Command   6. Change Configuration  9. Display Disk Directory (OFF)
A,B - Change Drive                                0. End Communication/Program
                         Press F2 For Help
Enter Selection: 1       O(riginate, A(nswer, D(ata: O
Enter Label: X           Phone Number: 8,058371,3016210350

Communication Directory:

 A - CompuServe Direct      J - OAG EE Telenet         S - CompuServe Datapac
 B - CompuServe Telenet     K - OAG EE Tymnet          T - DJN/R Datapac
 C - CompuServe Tymnet      L - OAG EE UNINET          U - KNOWLEDGE INDEX Data
 D - DJN/R Telenet          M - THE SOURCE Direct      V - OAG EE Datapac
 E - DJN/R Tymnet           N - THE SOURCE Telenet     W - THE SOURCE Datapac
 F - DJN/R UNINET           O - THE SOURCE UNINET      X - NASA RECON
 G - KNOWLEDGE INDEX Tel    P - Honeywell              Y - DEC VAX 11/780
 H - KNOWLEDGE INDEX Tym    Q - Lawrence Laboratory1   Z - Standard Values
 I - MCI Mail               R - Lawrence Laboratory2

Smartmodem: WAITING

  2:46 pm                Tuesday March 10, 1987                    CAPS
```

Screen 5. Smartcom II Master Menu with Communications Directory.

Smartcom II now dials the NASA RECON phone number -- you will hear the audible tones -- and links you to the RECON computers.

NASA RECON
Menu: F1 Print: F3 Disk: F4 Macro: F5 Break: F6
11:11 pm Tuesday March 10, 1987 CAPS

Screen 6. Smartcom II Remote Access Menu.

When linked to a database system, only the lower three lines of the screen relate to Smartcom II -- the set (NASA RECON), the Smartcom II options (F1, F3, F4, F5, F6) and the time, date and CAPS indicator (keyboard set to capital letters).

In remote access, Smartcom II functions in the background mode with NASA RECON in the control mode. Your Smartcom II options are limited to:

F1 -- a return to the main menu
F3 -- printing
F4 -- storing to disk
F5 -- invocation of a macro
F6 -- break

Only F1 and F4 are of interest to us in this demonstration. F1 is used to "hang-up" the phone and F4 is used to store all RECON information to a removable disk file. This is a great advantage of Smartcom II.

---

Keystroke(s)

1. Enter F4 (no carriage return)
   (store RECON information to disk file)

---

Screen 7 now appears.

```
A:TEMP  0%NASA RECON
 Receive File:  Press F1 To Complete, F4 To Suspend
  11:15 pm                   Tuesday March 10, 1987                    CAPS
```

Screen 7. Smartcom II Remote Access Menu.

You are now storing all information that appears on the screen -- aside from the three Smartcom II lines -- to a removable disk in drive A. Smartcom II first stores the data in an internal buffer. The 0% indicates the amount of information in the internal buffer and <u>not</u> the amount of data transmitted to the disk. As the internal buffer fills, the percent indicator increases to 100. At this point, the data is automatically transferred to the disk, the indicator is reset to 0, and the process repeated. "A" indicates the target drive -- set in Screen 4 -- and "TEMP" is a system designation.

It is a good idea to store the search strategy in one file and the citations in another.

---

Keystroke(s)

**When you have completed the search**

1. Enter F1 (no carriage return)
   (allows the user to rename the TEMP file and completes the data transfer process)

---

Screen 8 now appears.

```
Rename File Received: A:
A:TEMP  0%NASA RECON
 Receive Complete  0 lines
  10:57 pm                    Tuesday March 10, 1987                 CAPS
```

Screen 8. Smartcom II Remote Access Menu.

You must now rename your stored file (held temporarily under TEMP). Choose any series of characters you like except TEMP. It is a good idea to use an acronym to identify the file (something related to the search followed by SS for search strategy and C for citations). A search on turbines might employ TURBSS and TURBC.

---

Keystroke(s)

Once you have stored the search strategy, reinvoke F4

1. Enter the selected file name -- TURBSS in the above example -- following [A:]
   (this completes the disk storage of the search strategy)

2. Enter F4 (no carriage return)
   (to store your citation file.)

After completing the citations,

3. Enter F1 (no carriage return)

4. Enter the selected file name -- TURBC in the above example -- following [A:].
   (this completes the disk storage of the citations)

---

The NASA RECON screens of the practice set were "stored" in the above manner. They were subsequently printed using Smartcom II's **Select File Command** -- more on this later. Screens 6, 7, and 8 were developed using only RECON's carrier (RECON is online from 8:00 a.m. to 6:00 p.m. EST) to illustrate the file processes. All of the screens were produced using **Shift-PrtSc** since this is difficult (and expensive) to do online.

```
SELECT SYSTEM APPLICATION
B/RECON

READY TO IBM
SIGNON

            PLEASE ENTER USERID:
XXXXXXXXMMMMMMMMWWWWWWWW

            USERID ACCEPTED.

BEGIN SEARCH

BEGIN-SEARCH/ENTER DATA IN THE SAME ORDER FOR THE FOLLOWING FIELDS, SEPARATED BY
SEMICOLONS: SEARCH TITLE; SEARCHER'S NAME; REQUESTOR'S NAME; STREET ADDRESS;
CITY/STATE/ZIP; SET SAVE(YES); AND FILE COLLECTION CODE. ENTER ALL FIELDS.
PRIME AND ALTERNATE DATA BASES ARE ONLHNE. THE FOLLOWING FILES ARE AVAILABLE TO
SEARCH IF YOU ARE AUTHORIZED:
A  Aerospace Database: STAR, IAA.......................1968 to Present
B  All Unlimited, Unclassified Series..................1968 to Present
C  Contracts (R&DCS)...................................1968 to Present

B:DEMO2
 Press F1 To Cancel  Press A Key To Continue
   5:45 pm                   Tuesday March 10, 1987
```

Screen 9. NASA RECON.

This is the first of the NASA RECON screens.

---

Keystroke(s)

1. Enter carriage return

   [SELECT SYSTEMS APPLICATION] prompt appears

2. Enter B/RECON

   system response [READY TO IBM] appears

3. Enter SIGNON

   system responds with [PLEASE ENTER USERID:]
   [XXXXXXXXMMMMMMMMWWWWWWWW]

4. Enter your user ID following the string of X..M..W. (This has purposely been left blank on Screen example)

   system responds with [USERID ACCEPTED]

5. Enter BEGIN SEARCH

---

Note the sequence of SEARCH TITLE; SEARCHER'S NAME; ... You must enter this data on the following screen (Screen 10). The remainder of this screen lists searchable files provided by the system.

```
D  Primary R&D (Includes A, B, C, E, and I).............1968 to Present
E  Research in Progress (R&DCS, RTOPS, RR)..............1968 to Present
F  NALNET Books.........................................Various
G  Earlier Series (Some For Record Only)................Various
H  Earlier Series (Unlimited; Some For Record Only).....Various
I  Aerospace Safety R&D Institute (ASRDI)...............1975-1976
L  Registration and Product Control.....................Current
M  NALNET Periodicals...................................Various
N  NALNET Books (F) and Primary R&D (D).................Various
O  Primary R&D--Except Some Limited and Classified......1968 to Present
P  NALNET Books and Primary R&D--Except Some Limited
P     and Classified....................................Various
Q  Directory of Numerical Databases.....................Various
R  NASA Safety Reports..................................Various
ENTER:DEMO;G DAVID HUFFMAN;G DAVID HUFFMAN;UNIVERSITY OF SOUTHERN MISSISSIPPI;HA
TTIESBURG, MS 39401;NO;A

***** BEGIN SEARCH *****
***** BEGIN SDEMO
DATE/FILE    3-10-87/D
PRIMARY   DATA BASE ONLINE

B:DEMO2
 Press F1 To Cancel  Press A Key To Continue
   5:19 pm                 Tuesday March 10, 1987                    CAPS
```

Screen 10.  NASA RECON.

This completes the list of searchable files (see Chapter 4 for an explanation).

After you enter BEGIN SEARCH (see Screen 9 keystrokes), RECON will respond with:

(a) a BEGIN-SEARCH/ENTER ..... phrase which provides a list of data which must be entered by you,
(b) a list of available search files, and
(c) an ENTER: prompt.

---

Keystroke(s)

RECON pauses after giving the [ENTER:] prompt so that you can supply the following data (listed on Screen 9). Data entry items must be in the order shown. A semicolon (;) is used to delimit each item.

1. Enter "search title";      (no carriage return)
2. Enter "searcher's name";   (no carriage return)
3. Enter "requestor's name";  (no carriage return)
4. Enter "street address"     (no carriage return)
5. Enter "city/state/zip";    (no carriage return)
6. Enter "yes" or "no"        (no carriage return)
   (set save)
7. Enter "file collection code"
   (file collection codes for searchable files listed on Screens 9 and 10)

---

```
NO.   REC.   OCC.   (+=OR, *=AND, -=NOT)
---   -----  -----  ---------------------


                    WELCOME TO NASA RECON

   RECON NOW PROVIDES FOUR LEVELS OF HELP MESSAGES DETERMINED BY THE USER'S
   LEVEL OF EXPERIENCE. THEY ARE AS FOLLOWS:

   CODE                      DESCRIPTION
    N ---> "NO HELP", THE USER WILL NOT RECEIVE THE SPECIFIC ERROR MESSAGE JUST
           "INVALID COMMAND-NO HELP SPECIFIED" WILL BE DISPLAYED ON THE
           TERMINAL.
    E ---> "EXPERT", THE USER WILL RECEIVE A SHORT DESCRIPTION OF THE ERROR
           ENCOUNTERED.
    I ---> "INTERMEDIATE", THE USER WILL RECEIVE THE ABOVE INFORMATION ALONG
           WITH ADDITIONAL TEXT DESCRIBING THE ERROR.
    B ---> "BEGINNER", THE USER WILL RECEIVE THE INTERMEDIATE MESSAGE ALONG
           WITH SUGGESTIONS FOR POSSIBLE CORRECTIONS.

   PLEASE ENTER THE DESIRED CODE FOLLOWED BY A TRANSMIT <CR> TO SPECIFY YOUR

B:DEMO2
 Press Fl To Cancel  Press A Key To Continue
   5:21 pm                 Tuesday March 10, 1987                 CAPS
```

Screen 11. NASA RECON.

RECON generates this screen with no user intervention. Note that the first line gives:

- NO. (number of the search statement)
- REC. (number of records)
- OCC. (number of occurrences).

These terms are explained in detail in Chapter 4.

RECON provides variable levels of help and you enter an appropriate choice -- N, E, I, OR B -- following the PLEASE ENTER .... statement.

```
DEFAULT LEVEL OF EXPERT WILL BE ISSUED
          >>> PLEASE START YOUR SEARCH NOW <<<

IF YOU ATTEMPT TO DISPLAY ENTRIES OF LIMITED OR CLASSIFIED REPORTS YOU WILL
                         RECEIVE THE FOLLOWING MESSAGE:

*******************************************************************************
THIS DOCUMENT IS IN REFERENCE TO RESTRICTED INFORMATION AND CANNOT BE DISPLAYED
BASED UPON YOUR CURRENT REGISTRATION AT THE STI FACILITY.
*******************************************************************************

IF THERE ARE ANY QUESTIONS CONCERNING ACCESS TO DOCUMENTS
PLEASE CONTACT NASA AT 202-453-290.
*******************************************************************************

                                NOTICE

                          ***  STI BULLETIN  ***


B:DEMO2
 Press Fl To Cancel  Press A Key To Continue
   5:36 pm                   Tuesday March 10, 1987
```

Screen 12. NASA RECON.

This is a RECON generated screen related to help level and restricted data.

```
                   NEW LOOK|      NEW NAME|
ENTER:SELECT AX/COOLING

  1  12342  18550 AX/COOLING
ENTER:SELECT AX/'ELECTRONIC EQUIPMENT'

  2    581    645 AX/ELECTRONIC *+1 EQUIPMENT
ENTER:SELECT AX/'HEAT PIPES'

  3    941   1631 AX/HEAT *+1 PIPES
ENTER:COMBINE 1 AND 2 AND 3

  4      8     39 1 AND 2 AND 3
ENTER:SELECT AX/ELECTRONICS

  5   3892   4536 AX/ELECTRONICS
ENTER:COMBINE 1 AND 3 AND 5

  6     10     35 1 AND 3 AND 5
ENTER:COMBINE 3 AND 5

B:DEMO2
 Press F1 To Cancel  Press A Key To Continue
   5:23 pm                  Tuesday March 10, 1987                    CAPS
```

Screen 13. NASA RECON.

This is the first of two search screens. This search was conducted to find information on cooling electronic equipment with heat pipes. The syntax is explained in depth in Chapter 4.

---

Keystroke(s)

Following the system prompt [ENTER:]

1. Enter SELECT AX/COOLING

System responds with [1 12342 18550 AX/COOLING] (where the items are related to NO., REC., and OCC. -- see headings of Screen 11).

---

You may want to try to find citations related to your own problem. If so, formulate your search offline.

```
 7     30     74 3 AND 5
ENTER:BROWSE 7/2/1

          BROWSE  7/2/1
      86A39938#   ISSUE 18   PAGE 2621   CATEGORY 18   RPT#: AIAA PAPER 86-1339
      86/06/00  10 PAGES   UNCLASSIFIED DOCUMENT
UTTL: Thermal design verification of a high-power direct broadcast satellite
AUTH: A/WISE, P.;  B/RAISCH, J.;  C/KELLY, W.;  D/SHARMA, S. P.   PAA: B/(RCA,
      Astro-Electronics Div., Princeton, NJ);  C/(COMSAT Laboratories,
      Clarksburg, MD);  D/(COMSAT, Technical Services, East Windsor, NJ)
CIO:  UNITED STATES
      AIAA and ASME, Joint Thermophysics and Heat Transfer Conference, 4th,
      Boston, MA, June 2-4, 1986. 10 p.
MAJS: /*COMMUNICATION SATELLITES/*HEAT PIPES/*SATELLITE DESIGN/*SATELLITE
      TEMPERATURE/*SPACECRAFT RADIATORS/*TEMPERATURE CONTROL
MINS: / DESIGN ANALYSIS/ FLIGHT TESTS/ PANELS/ PERFORMANCE TESTS/ THERMAL
      ANALYSIS/ TRANSFER ORBITS
ABA:  Author
ABS:  The direct broadcast satellite (DBS) designed and manufactured by RCA
      Astro-  **  Electronics  **   Division for Satellite Television Corp. (a

B:DEMO2
 Press Fl To Cancel  Press A Key To Continue
   5:24 pm                 Tuesday March 10, 1987                     CAPS
```

Screen 14.  NASA RECON.

---

Keystroke(s)

After the system prompts [ENTER:]

1. Enter BROWSE 7/2/1  (to view the first of your citations)

   (Consult the RECON Command Language Table for proper syntax. You can view -- browse -- as many citations as you like.)

If you are satisfied with your search,

2. Enter Fl  (no carriage return)
   (to store your search strategy file on disk -- see Screen 8)

3. Rename your file as described in the Screen 8 narrative.

You are now in Smartcom II which returns you to NASA RECON.

4. Enter F4 (no carriage return)   (to save the citation file)

NASA RECON will be waiting with an [ENTER:] prompt during this process.

5. Enter BROWSE 7/2/ALL

Following this process -- taking about 45-60 seconds per citation at 300 baud:

6. Enter Fl  (no carriage return)
   (to rename your citation file)

7. Enter the selected file name (don't forget this last rename)

MAJS: /*COMMUNICATION SATELLITES/*HEAT PIPES/*SATELLITE DESIGN/*SATELLITE TEMPERATURE/*SPACECRAFT RADIATORS/*TEMPERATURE CONTROL
MINS: / DESIGN ANALYSIS/ FLIGHT TESTS/ PANELS/ PERFORMANCE TESTS/ THERMAL ANALYSIS/ TRANSFER ORBITS
ABA: Author
ABS: The direct broadcast satellite (DBS) designed and manufactured by RCA Astro- ** Electronics ** Division for Satellite Television Corp. (a subsidiary of COMSAT) uses ** heat pipes ** for thermal control of the primary spacecraft payload heat rejection radiators. Operational limitations imposed by gravitational effects on heat pipe performance govern the design of the spacecraft test fixture and the thermal design verification test program. This paper discusses the rationale behind the test program and presents the results of the qualification test model (QTM) thermal vacuum test. Test temperatures compared with analytical predictions demonstrate the validity of the thermal design verification program. Additionally, the benefits of a QTM spacecraft assembly and test program prior to flight spacecraft assembly and test are reviewed.
ENTER:SIGNOFF

SIGNOFF ACCEPTED, SESSION DURATION 9.71 MINS., USER DISCONNECTED.

B:DEMO2
Press F1 To Cancel Press A Key To Continue
5:38 pm Tuesday March 10, 1987

Screen 15. NASA RECON.

Having transferred all citations, entered F1 and renamed your disk file, you can now sign off.

---

Keystroke(s)

1. Enter SIGNOFF

2. Enter F1 (no carriage return)

---

Screen 16 now appears.

```
Smartcom II                   Hayes Microcomputer Products, Inc.

*. Begin Communication  4. Receive File         7. Change Printer Status  (OFF)
2. Edit Set             5. Send File            8. Select Remote Access   (OFF)
3. Select File Command  *. Change Configuration 9. Display Disk Directory (OFF)
A,B - Change Drive                              0. End Communication/Program
                        Press F2 For Help
Enter Selection: 0      E(xit, H(ang up, V(oice: H


Communication Directory:

 A - CompuServe Direct      J - OAG EE Telenet       S - CompuServe Datapac
 B - CompuServe Telenet     K - OAG EE Tymnet        T - DJN/R Datapac
 C - CompuServe Tymnet      L - OAG EE UNINET        U - KNOWLEDGE INDEX Data
 D - DJN/R Telenet          M - THE SOURCE Direct    V - OAG EE Datapac
 E - DJN/R Tymnet           N - THE SOURCE Telenet   W - THE SOURCE Datapac
 F - DJN/R UNINET           O - THE SOURCE UNINET    X - NASA RECON
 G - KNOWLEDGE INDEX Tel    P - Honeywell            Y - DEC VAX 11/780
 H - KNOWLEDGE INDEX Tym    Q - Lawrence Laboratory1 Z - Standard Values
 I - MCI Mail               R - Lawrence Laboratory2

Smartmodem: HANGUP

 12:36 am                   Wednesday March 11, 1987                  CAPS
```

Screen 16. Smartcom II Master Menu.

You have now exited NASA RECON, but you still must hang-up the phone.

---

Keystroke(s)

System prompt [Enter Section:]

1. Enter 0 (no carriage return)
   (End Communication/Program)

System prompt [Smartmodem:]

2. Enter H (no carriage return)
   (Hang up)

You are now offline. To view your files,

System prompt [Enter Selection:]

3. Enter 3 (no carriage return)
   (Select File Command)

4. Enter D or P (no carriage return)
   (Display or Print)

As a result of entering D or P, Screen 17 is produced.

```
    Smartcom II           Hayes Microcomputer Products, Inc.

 1. Begin Communication  *. Receive File         7. Change Printer Status  (OFF)
 2. Edit Set             *. Send File            *. Select Remote Access   (OFF)
 3. Select File Command  6. Change Configuration 9. Display Disk Directory (OFF)
 A,B - Change Drive                              0. End Communication/Program
                         Press F2 For Help
 Enter Selection: 3      C(reate, D(isplay, P(rint, R(ename, E(rase: D
 Enter File Name: B:DEMO2




   12:30 am              Wednesday March 11, 1987                    CAPS
```

Screen 17. Smartcom II Select File Command Menu.

You must now enter the file names of your search strategy file and citation file. They will be displayed in turn.

---

Keystroke(s)

System prompt [Enter File Name:]

1. Enter "filename"

Your search strategy or citations will be displayed. They will look like Screens 9 through 16.

To terminate Smartcom II,

2. Enter O (no carriage return)
   (End Communication/Program)

3. Enter E (no carriage return)
   (Exit)

This produces a screen like number 16 with E rather than H.

This completes the use of Smartcom II and NASA RECON. Next is SORT-AID.

```
C:\DEMO>PREPROC
Copy from:    DEMO.N00
     to:      DEMO.N01
Enter maximum line length of output file (2-132) > 80

C:\DEMO>NABST

What is the project number?                   > DEMO
What is the extension of the input file?      > N01
What identifying text would you like appended
to the citation printouts (max 20 chars)      > SORT-AID demo
Is this the first file processed for this project number (Y/N) ? [N] > Y
Do you wish to create files for later use of rank (Y/N) ? [Y]   > Y

C:\DEMO>
```

Screen 18. SORT-AID.

You now have your citations captured on disk file. Unfortunately, NASA RECON does not insert a carriage return-line feed on lines that are exactly 80 characters long. The SORT-AID preprocessor corrects this.

---

Keystrokes

1. Following the [C:/DEMO>] prompt, enter PREPROC.

2. Following the [Copy from:] prompt, enter your file name for the citations -- DEMO.N00 in the present case. Note that the file extension must begin with an N.

3. Following [to:] prompt, enter your new file name for the citations -- DEMO.N01 in the present case.

4. Following the [Enter maximum line...>] prompt, enter 80.

5. The system now responds with [C:\DEMO>]. Enter NABST.

6. Following the next series of prompts, enter a project name, file extension (which must start with N for NASA RECON), identifying text, Y and Y. This completes NABST.

7. The system will respond with [C:\DEMO>].

---

```
C:\DEMO>RANK

What is the project number to use? > DEMO
```

Screen 19. SORT-AID.

You are now ready to enter RANK.

---

Keystrokes

1. Following the [C:\DEMO>] prompt, enter RANK.

2. Following the [What is ....? >] prompt, enter your project number -- DEMO in the present case.

---

```
                 RANK OPTIONS MENU

       0. -- Stop program and return to OS
       1. -- Create index and query
       2. -- New query with existing key word index
       3. -- Create NEW index and query with existing RANK work files

  Enter option(0-3) [1] > 1


  What is the minimum word length of index terms?
  Please enter a length between 1 and 30 [1] > 3

  What is the maximum word length of index terms?
  Please enter a length between 3 and 30 [30] > 30
```

Screen 20. SORT-AID.

This is the RANK OPTIONS MENU.

---

Keystrokes

1. Following the [Enter option ..>] prompt, enter 1. The other options, along with additional information on various SORT-AID commands, are given in Chapter 7.

2. Following the [What is the minimum ...>] prompt, enter a minimum word length -- 3 in this case.

3. Following the [What is the maximum ...>] prompt, enter a maximum word length -- 30 in this case.

---

```
RANK AUTOMATIC INDEXING METHOD MENU

     0. -- Stop program and return to OS
     1. -- Compute word weights using frequency of occurrence
     2. -- Compute word weights using signal-to-noise ratio
     3. -- Compute word weights using binary frequency of occurrence

  Enter option(0-3) [1] > 1


  Input routine -- sending  records to sort:


  Done with input -- sorting 2480 records . . .




  Computing sums . . .
        2480 characteristic words in 30 citations
         823 unique characteristic words

  Computing weights . . .
```

Screen 21. SORT-AID.

This is the AUTOMATIC INDEX METHOD MENU. These features are explained in Chapter 7.

---

Keystrokes

1. Following the [Enter option ...>] prompt, enter 1. The system responds with:

```
Input routine ...
Done with ...
Computing sums ...
    .
    .
Computing weights ...
```

---

| User Value | Index Term | <ESC><ESC> When Done | Weight | Current Word # | 4 |
|---|---|---|---|---|---|
| 0 | PIPE | | 155.8116 | | |
| 0 | THERMAL | | 126.4208 | | |
| 0 | NTIS | | 124.2411 | | |
| 0 | TEMPERATURE | | 85.7559 | | |
| 0 | SPACE | | 78.0344 | | |
| 0 | ELECTRONIC | | 77.9058 | | |
| 0 | COOL | | 75.7238 | | |
| 0 | POWER | | 74.1763 | | |
| 0 | ENERGY | | 72.2541 | | |
| 0 | EXPERIMENT | | 68.4704 | | |
| 0 | FLIGHT | | 67.3026 | | |
| 0 | SPACECRAFT | | 65.1516 | | |
| 0 | RESISTANCE | | 60.8944 | | |
| 0 | SATELLITE | | 60.2181 | | |
| 0 | PERFORMANCE | | 55.2927 | | |
| 0 | THERMODYNAMIC | | 54.0544 | | |
| 0 | ENGINEER | | 52.0229 | | |
| 0 | UTILIZATION | | 50.2440 | | |
| 0 | MODULE | | 48.3321 | | |
| 0 | RADIATOR | | 46.0492 | | |
| 0 | NUCLEAR | | 44.3044 | | |

Enter value for TEMPERATURE [10] > 20

Screen 22. SORT-AID.

This is the index term list generated using RANK. There are five screens containing the index terms -- 100 words. Each term can be assigned a relevance value between -9999 and 9999. Negative values are used for non-relevant and positive values for relevant terms. Neutral terms should be left with 0. Relevance values are assigned using the following keystrokes.

---

Keystrokes

1. Strike either D ( ) or U ( ) to align the cursor with the term to be assigned a new relevance value.

2. Enter ENTER. The system will respond with a prompt at the bottom of the screen.

3. Following the [Enter value for ...>] prompt, enter the desired value -- 20 in the present case. The 20 will appear on the screen with the cursor positioned adjacent to the selected word.

4. Continue this process for as many words as desired.

---

| User Value | Index Term | <ESC><ESC> When Done | Weight | Current Word # 10 |
|---|---|---|---|---|
| 0 | PIPE | | 155.8116 | |
| 0 | THERMAL | | 126.4208 | |
| 0 | NTIS | | 124.2411 | |
| 20 | TEMPERATURE | | 85.7559 | |
| 0 | SPACE | | 78.0344 | |
| 20 | ELECTRONIC | | 77.9058 | |
| 0 | COOL | | 75.7238 | |
| 0 | POWER | | 74.1763 | |
| 0 | ENERGY | | 72.2541 | |
| 20 | EXPERIMENT | | 68.4704 | |
| 0 | FLIGHT | | 67.3026 | |
| 0 | SPACECRAFT | | 65.1516 | |
| 0 | RESISTANCE | | 60.8944 | |
| 0 | SATELLITE | | 60.2181 | |
| 0 | PERFORMANCE | | 55.2927 | |
| 0 | THERMODYNAMIC | | 54.0544 | |
| 0 | ENGINEER | | 52.0229 | |
| 0 | UTILIZATION | | 50.2440 | |
| 0 | MODULE | | 48.3321 | |
| 0 | RADIATOR | | 46.0492 | |
| 0 | NUCLEAR | | 44.3044 | |

Screen 23. SORT-AID.

Having now assigned values to the relevant or non-relevant terms, you must terminate this process. Again, this is the first screen of the 100 index terms.

---

Keystrokes

1. Enter <ESC><ESC>.

---

```
Writing out top word file
  100


Computing ranks . . .
   30

C:\DEMO>
```

Screen 24. SORT-AID.

This is all system generated. SORT-AID is now ordering the citations by relevance order. You can now review the citations using the REVIEW program (see Chapter 7 for a complete description of the REVIEW commands).

This process is described in the following screens.

```
C:\DEMO>REVIEW
```

Screen 25. SORT-AID.

This is the first of the REVIEW screens.

---

Keystrokes

1. Following the [C:\DEMO>] prompt, enter REVIEW.

---

```
What project number do you wish to review?          > DEMO

Do you want to use the relevance directory? (Y/N) [N] > Y

REVIEW>
```

Screen 26. SORT-AID.

Having installed REVIEW, you now select the file and review order for the citations.

---

Keystrokes

1. Following the [What project number ...>] prompt, enter your project name -- DEMO in this example.

2. Following the [Do you want ...>] prompt, enter Y.

3. Following the [REVIEW>] prompt, enter a carriage return. This will produce the first citation screen (Screen S10).

---

```
relative #    1 --  absolute #    19
 Citation criteria:


      80N28680#   ISSUE 19   PAGE 2568   CATEGORY 34   RPT#: PB80-809940
      80/04/00  254 PAGES   UNCLASSIFIED DOCUMENT
UTTL: Heat pipes.  Citations from the NTIS data base   TLSP: Progress Report,
      Mar. 1976 - Mar. 1979
AUTH: A/REED, W. E.
CORP: National Technical Information Service, Springfield, Va.    AVAIL.NTIS
SAP:  HC $30.00/MF $30.00
CIO:  UNITED STATES
MAJS: /*AIR CONDITIONING EQUIPMENT/*BIBLIOGRAPHIES/*HEAT PIPES/*HEATING
      EQUIPMENT/*PIPES (TUBES)
MINS: / CIRCULAR TUBES/ COOLING SYSTEMS/ NUCLEAR REACTORS/ THERMODYNAMICS/ TUBE
      HEAT EXCHANGERS
ABA:  GRA
ABS:  Theory, design, fabrication, testing, and operation of   ** heat pipes
      **  are presented in these Federally-sponcored research reports.
      Applications are described in the areas of heating and air conditioning,

<Press RETURN for more of this citation or enter command>

REVIEW>
```

Screen 27. SORT-AID.

This is the first citation screen. Note the relative position -- 1 -- and the absolute (as-captured) position -- 19. You can now use all the features of REVIEW -- categorization, deletion, string searches, etc. (see Chapter 7).

---

Keystrokes

1. Following the [REVIEW>] prompt, enter a carriage return. This will produce the remainder of the current citation.

---

power generation, ** electronics ** cooling, spacecraft, nuclear reactors, cooling engines, and thermodynamics. This updated bibliography contains 247 abstracts, none of which are new entries to the previous edition.

REVIEW>

Screen 28. SORT-AID.

This completes the first citation.

The practice set is now completed. You can formulate a search and repeat the process for your own technology transfer studies.

---

Keystrokes

1. Following the [REVIEW>] prompt, enter a carriage return to view the remaining citations

   or

2. Enter a Q to terminate processing.

---

# Report Documentation Page

NASA
National Aeronautics and Space Administration

| | | |
|---|---|---|
| 1. Report No. NASA CR-181403 | 2. Government Accession No. | 3. Recipient's Catalog No. |
| 4. Title and Subtitle Using Bibliographic Databases in Technology Transfer | | 5. Report Date October 1987 |
| | | 6. Performing Organization Code |
| 7. Author(s) G. David Huffman, Ph.D. | | 8. Performing Organization Report No. |
| | | 10. Work Unit No. 141-20-00-00 |
| 9. Performing Organization Name and Address College of Science and Technology University of Southern Mississippi Southern Station, Box 5165 Hattiesburg, MS 39406 | | 11. Contract or Grant No. NS-2402 |
| | | 13. Type of Report and Period Covered Contractor Report |
| 12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546-0001 NASA/National Space Technology Laboratories NSTL, MS 39529 | | 14. Sponsoring Agency Code |

15. Supplementary Notes

Robert M. Barlow
NASA/National Space Technology Laboratories
NSTL, Mississippi 39529

16. Abstract

When technology developed for a specific purpose is used in another application, the process is called technology transfer--the application of an existing technology to a new use or user for purposes other than those for which the technology was originally intended.

This book, USING BIBLIOGRAPHICAL DATABASES IN TECHNOLOGY TRANSFER, deals with demand-pull transfer--technology transfer that arises from need recognition, and is a guide for conducting demand-pull technology transfer studies. It can be used by a researcher as a self-teaching manual or by an instructor as a classroom text.

A major problem of technology transfer is finding applicable technology to transfer. This report describes in detail the solution to this problem--the use of computerized, bibliographic databases, which currently contain virtually all documented technology of the past 15 years. A general framework for locating technology is described. NASA technology organizations and private technology transfer firms are listed for consultation.

| 17. Key Words (Suggested by Author(s)) | 18. Distribution Statement |
|---|---|
| Technology Transfer, Search Automation, Database Searching, Microcomputer Software, Bibliographic Databases, Search Post-Processing Software | Unclassified--Unlimited Subject Category 62 |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No. of pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 221 | A10 - A13 |

NASA FORM 1626 OCT 86

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